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THE GROSS AND NET EARNINGS OF RAILWAYS in the United States for the calendar year of 1890 as compared with those of the previous year are as follows, according to statistics collected by the *Financial Chronicle:*

Jan. 1 to Dec. 31.	Gross earnings.		Net earnings.		
	1890.	1889.	1890.	1889.	Inc.
	$	$	$	$	P. c.
Trunk.....	272,591,793	256,549,161	84,652,117	82,641,038	2.43
Mid. W'n..	49,776,826	46,138,203	17,827,477	17,095,789	4.28
N'w'n.....	126,338,046	118,300,471	43,435,274	42,575,280	2.02
So'w'n....	68,767,372	60,814,175	21,595,233	19,840,694	8.84
Pac.....	135,126,611	125,473,922	48,493,722	47,563,634	1.96
So'n.....	83,867,252	74,840,343	27,237,402	24,912,480	9.33
Coal co's..	109,674,874	103,417,221	33,367,765	30,983,568	7.70
E'n & Mid.	111,818,255	102,861,537	37,591,198	33,821,959	11.15
Mexican ..	3,754,966	3,060,124	827,006	666,694	24.05
Total, 187 rds.....	961,715,975	892,055,160	315,027,194	300,161,130	4.97
11 months (19 rds)..	45,824,793	43,344,078	12,982 264	13,679,433	5.10
Gr. total (206 rds.).	1,007,540,768	935,399,238	328,009,458	313,780,569	4.53

MILEAGE.—The mileage for the above groups is as follows: Trunk lines, 18,531 miles in 1890, against 18,389 in 1889; Middle Western, 9,091, against 8,906; Northwestern, 24,776, against 24,524; Southwestern, 14,014, against 13,971; Pacific systems, 23,928, against 22,991; Southern roads, 13,815, against 13,083; coal companies, 4,9 7, against 4,880; Eastern and Middle, 8,411, against 8,354; Mexican, 1,218, against 1,218. Total, 118,691, against 116,316. Mileage of roads given for eleven months is 9,541, against 9,153, making a grand total of 128,232, against 125,469.

IMMIGRATION tends to increase, which is apt to be a pretty sure indication of "good times," for the immediate future, at least. For the month of January 14,787 immigrants arrived this year against only 11,298 last year, which was a year showing a considerable increase over 1890. The increase is chiefly in German and Russian immigration.

THE GUNBOAT *Bennington* in her late trial trip exceeded her contract guarantee, and earns a bonus for her builders, at the rate of 3,471.7 HP, as compared with 3,400 HP called for. The boat behaved very well in rough water, but was very wet. The highest steam pressure was 170 lbs.; the maximum revolutions of the two screws were 158.9 and 150.9. The highest speed attained was 17.2 knots, with an average of about 16.5 knots. The boat was turned sharply at full speed, and went from full speed ahead to full speed astern in 1 min. 6 sec., and a dead stop was made in 375 ft. from full speed with 106 revolutions.

THE SIOUX CITY ELEVATED RAILWAY, which will probably be completed this month, is 7,123 ft. long, 5,554 ft. being a double track, standard gage iron viaduct and the remainder consisting of timber trestles and embankments. The grade on the viaduct is 0.5%, on the embankment and trestles its maximum value is 1.9%. The metal work is principally steel, and is supplied by the King Iron Bridge Co. The structure was designed to carry a moving load of 1,500 lbs. per lin. ft. of each track, but the posts are strong enough to support twice this weight, so that additional strength may be secured when necessary by laying two more girders without disturbing those already in place.

THE VALUE OF STRONG CAR HEATERS was recently demonstrated on the Baltimore & Ohio Southwestern R. R. On Feb. 23, as a train was side-tracked to let No. 4 pass at Remington, O., No. 4 came around the curve before the other train had got clear of the main track at such speed that it was impossible to stop it, and it scraped the side of the third car of the side-tracking train for about 13 ft., catching the fourth car under the corner and turning it over on its side into the ditch. Several persons were injured thereby. The car was equipped with the Consolidated Car Heater Co.'s fireproof heater, located in the corner struck by the engine. Though the heater was somewhat loosened from its fastenings, lifted and tipped, it was but slightly broken; and notwithstanding a brisk fire was burning in the heater, no conflagration took place. Had the car been equipped with an ordinary heater the trainmen reported that nothing could have prevented the car from burning.

THE PURIFICATION OF THE SEINE, by diverting the sewage formerly discharging into the river to a large collecting conduit, is going on rapidly. Last summer nine main sewers on the island of St. Louis, which formerly emptied into the Seine, were discharged into one sewer, and this is carried across to the right bank collector by a siphon. This siphon is made of two 15¾-in. wrought iron tubes, placed 10½ ins. apart, and laid in a bed of concrete. The total length is 344 ft. The siphon has a straight length of 209 ft., connected at the ends to curves. The whole pipe was floated into position on two pontoons, and sunk on a bed of concrete prepared for it. Before sinking an 8-in. bed of concrete was put in, and after the pipe had settled it was covered with concrete, so as to make a total concrete cover 2.8 ft. deep by 5.9 ft. wide. A similar siphon is being constructed for collecting the sewage of the Isle de la Cité.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a crossing collision on the New York, Lake Erie & Western R. R., at East Buffalo, N. Y., Feb. 27. An Erie freight train on the east-bound track was crossing the west-bound track to get onto the Niagara Falls line, when it was struck by a west-bound Lehigh Valley R. R. fast passenger train. Both engines were wrecked and the passenger cars were derailed. One man was killed and 6 were injured, two of them fatally.

BRIDGE ACCIDENTS are reported as follows: A bridge near Johnsonville, N. Y., on the Greenwich & Johnsonville Ry., was washed away Feb. 26. A trestle on the Southwestern R. R., near Fort Gaines, Ga., gave way under a passenger train Feb. 28. One man was killed. A portion of the pontoon bridge at St. Charles, Mo., was carried away Feb. 25.

FLOODS AND WASHOUTS are reported from various sections of the country, and the most serious results have occurred in California and Arizona. The flood in the Gila Valley, Arizona, has caused considerable damage and the loss of many lives, while the city of Yuma was practically destroyed. Several bridges have been destroyed and washouts caused near San Diego, Cal., and a dam at Pasadena has been carried away. Traffic on the Southern railways is interrupted in many places. In Colorado heavy snowstorms and slides have blocked some of the railways. High water in the rivers in eastern New York has interfered with the regular service of trains on the New York Central, West Shore and other roads, by causing washouts or floating ice over the tracks.

THE PARIS TESTING LABORATORY was commenced in 1867 to test paving material, and is under the direction of the administration of bridges and roads. In testing for cements, great care is taken with the samples submitted. An official of the department registers the weight at the station of departure and a Paris official attaches a lead seal to each sack on its arrival. The cost of inspection is partly borne by the cement makers, and the Passy company pays $300 annually and the Portland company $400 for this service. The details of tests are published quarterly, and in it a list of authorized makers is given. Cements are now being tested after being in stock three and four years, and with hot water *Le Genie Civil*, 1890, p. 402, describes this Paris laboratory in a general way.

THE PROPOSED BLACKWALL TUNNEL under the Thames, as advocated by the County Council, proposes construction by the pneumatic method. The tunnel would be 27 ft. in outside and 23 ft. in inside diameter, with a 16-ft. roadway and two footways. The estimated cost is $400 per lin. ft. The scheme has been favorably reported upon by Sir BENJAMIN BAKER and Mr. GREATHEAD and Mr. BINNIE.

THE STATE ENGINEER OF WYOMING is made one of the five members of the State Board of Commissioners to the World's Columbian Exposition of 1893. The office of the State Engineer is made the headquarters of the board, and this officer is practically to supervise the erection of the state buildings at the exposition, and, with the Governor, sell the building and such exhibits as are to be thus disposed of.

THE POWER-HOUSE of the Washington & Georgetown Cable Railway Co., now started, will cover an area of 240 by 190 ft., and will be six stories high, and is estimated to cost $450,000.

A GREAT MONOLITH of granite, large enough to dress to a pillar 6 ft. in diameter by 45 ft. long, has been already quarried near Petersburg, Va., and is tendered for a Confederate soldiers' monument for the sum of $10,000. The stone in the rough is said to weigh 200 tons. It is alleged that this would be the second largest monolithic round pillar in the world, the largest being Pompey's Pillar, 61 ft. high by 9 ft. in diameter. This may be so, but there are a dozen or more known obelisks of greater dimensions, ranging downward from 158×11.8 ft. to Cleopatra's Needle (67.1×8.1 ft.), the mate to which is in Central Park, New York. The largest monolith ever known to have been quarried is a block at Baalbec, 14×16×69 ft., measuring 15,456 cu. ft., against only 1,620 cu. ft. in the Petersburg block; which shows that in this art we have still something to learn.

LONDON TRAFFIC ON ASPHALT PAVEMENT is discussed in the report of C. B. BULL, C. E., to Commissioner of Public Works GILROY, of this city. On Feb. 21, 1889, 13,772 vehicles passed over the asphalt pavement on Cheapside in 24 hours; Feb. 52, 1888, 23,332 vehicles passed the Mansion House in the same time. Cornhill, Holborn Viaduct, Newgate St., and other streets in that neighborhood have a daily traffic of from 8,000 to 12,000 vehicles over their asphalt pavements.

JERUSALEM IS WAKING UP, says a contemporary. Baldwin locomotives are ready to enter its gates from Jaffa on a track about completed. And now comes electric light, just four years after the first introduction of gas. The electric light is used in a large flour mill, near the supposed site of Calvary and adjoining the Damascus Gate. It is little wonder that the modern Mohammedans are "astonished" at the work of the Western magicians, and call upon the Prophet for protection from this "chained lightning."

THE LAKE ERIE-OHIO RIVER SHIP CANAL REPORT has been presented to Gov. PATTISON by the commissioners, Messrs. JOHN A. WOOD, W. S. SHALLENBERGER, EBEN BREWER, JOHN M. GOODWIN and THOMAS P. ROBERTS. They approve of the Conneaut-Shenango route, 102.9 miles long to the Ohio River, insist upon the canal opening in Pittsburg harbor and estimate the total cost at $20,375,188.

The New Dam and Filter Bed at Bethel, Conn.

The water-works at Bethel, Conn., were built by the borough in 1878. The supply is surface water taken by gravity from an impounding reservoir on a small stream. The reservoir has a storage capacity of about 96,000,000 galls., and is formed by an earth dam 174 ft. long and 22¼ ft. high at its highest point. The supply main starts from the clear water apartment of a small filter chamber built in the upstream side of the dam. The filtering material is of charcoal and sponge, as shown in the accompanying illustrations. It is said that the filter chamber has worked well, but is now too small, and too expensive to operate, if properly cleaned and renewed.

Plans for a new filter bed have recently been made by W. B. Rider & Son, South Norwalk, Conn., to whom we are indebted for the accompanying information. Bids for its construction are now being received.

The plan, section and details of the filter bed and its connection with the impounding reservoir are shown by the illustrations. A dam will be built about 150 ft. below the existing dam and a filter bed constructed between the two dams. Water will pass from the reservoir through the present supply main until it reaches the gate chamber in the new dam. (See plan of same.) Here, by closing gate *A* and opening gate *B*, water will pass through the return pipe to the filter bed and discharge upon the top of the filter bed. The several drains shown on the plan will conduct the water, after it has passed through the sand and gravel, to the collecting well, from which it will pass back to the gate chamber in the new dam and, by opening the gate *C* and keeping *D* closed, into the supply main leading to the village. At any time when the filter bed is in operation and filtered water is passing to the village the gates *B* and *C* may be closed, gates *A* and *D* opened, when the village will be supplied with unfiltered water, or water passed through the old filter, and the bed will be drained. By reversing the flow, that is, by closing *B* and *D* and opening *A* and *C*, the unfiltered water can be introduced at the bottom of the bed and thus passed up through the filtering material, filling the space between the reservoirs and passing off through the overflow at the end of the dam. Or when the basin is filled the flow into it may be stopped and the gates *B* and *D* opened, when the water will be drawn from the top of the bed through the upturned inlet to the filter bed, shown in the section. This action presupposes another gate on the supply main, below gate *A* and the connection containing the gate *C*, and there should also be a gate at the collecting well, or somewhere between it and gates *C* and *D*. The overflow should also have a gate permitting water to be drawn down to the level of the top of the bed.

The total area of the bed will be about 13,000 sq. ft. The drain tile will be surrounded by stone, the bottom of the bed covered with coarse material, diminishing in size to fine sand at the top. About 3 ft. of sand will be used at first.

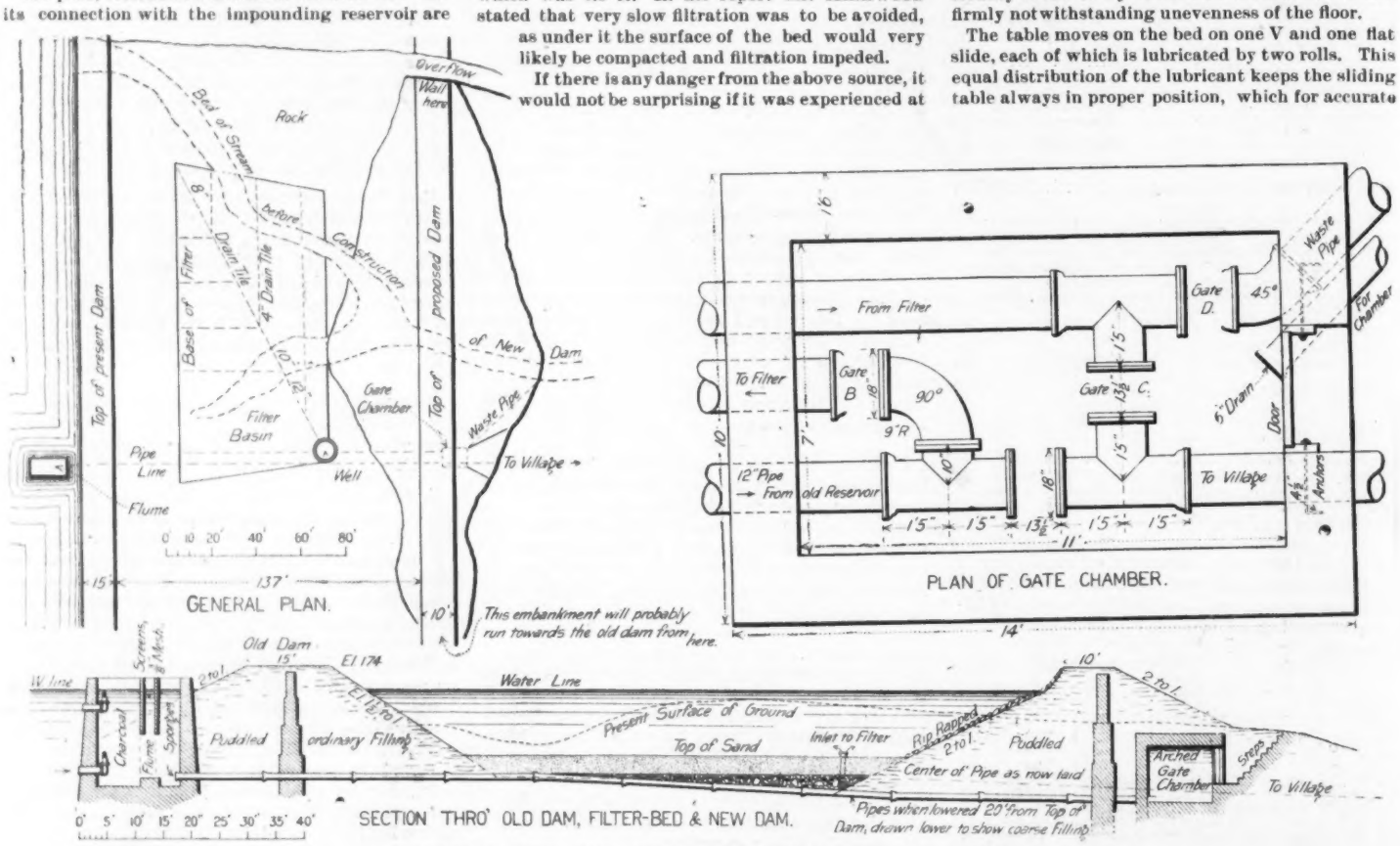
Mr. RIDER estimates that the rate of filtration will be 1.25 cu. ft. per 1 sq. ft. of bed per 24 hours, or 0.052 ft. per hour. This is far below the usual standard rate and only about one-tenth of the very low average rate established as desirable by Mr. JAMES KIRKWOOD in his "Filtration of River Waters," which was 0.5 ft. In his report Mr. KIRKWOOD stated that very slow filtration was to be avoided, as under it the surface of the bed would very likely be compacted and filtration impeded.

If there is any danger from the above source, it would not be surprising if it was experienced at Bethel, under the rate of filtration named. In addition, the cost of properly cleaning the filter and renewing the material will be very large for the amount filtered, especially if there should be an algæ growth upon the surface of the bed, as is probable. It is likely the same work could be done much more cheaply and quite as well with a smaller bed, and, had there been any head to spare, a commercial filter, under gravity pressure, would probably have been still cheaper and certainly more efficient. As it is the pressure in the distributing mains is but 70 lbs. to the square inch and the water, it seems, is very satisfactory through a good part of the year.

The reservoir serves as a settling basin and the old filter can be used whenever desired. This will be necessary while the new filter bed is being cleaned, and will remedy, in part, the lack of proper provision for cleaning and renewing, which might easily be secured by dividing into two beds.

After filtration the water passes directly to the consumers, without exposure to the light. This is desirable for water containing vegetable matter, but a small clear water basin, covered, for storage, would obviously be an advantage, especially as the bed is not in two sections for cleaning.

The population of the village is 3,400, and the estimated daily consumption of water is 120,000 galls. Bids for the construction of the dam and filter bed will be received until Monday, March 2, Messrs. E. C. OAKLEY, C. H. HART and A. TWISS are Water Commissioners for Bethel.



PROPOSED NEW DAM AND FILTER BED AT BETHEL, CONN

A New Universal Grinding Machine.

The Brown & Sharpe Mfg. Co., of Providence, R. I., is about to place on the market a new universal grinding machine, differing in many details from the grinding machines which the firm has been manufacturing for some years, and adapted to a large variety of work.

Figs. 1 and 2 show perspective views of the machine. It is mounted on a cast iron base of T-shaped section, cast in one piece with the bed, on which a table traverses. The base is in a form to give greatest stability and rigidity with least weight, and the machine is supported on three feet, one at each extremity of the T. By this means the machine stands firmly notwithstanding unevenness of the floor.

The table moves on the bed on one V and one flat slide, each of which is lubricated by two rolls. This equal distribution of the lubricant keeps the sliding table always in proper position, which for accurate grinding is of some importance. Upon the sliding table is mounted a swivel table, which turns on a central stud in the lower table and carries head and foot stocks. The line of centers of these can be set to make any desired angle with the line of motion of the lower table.

The swivel table is set to the desired angle by an adjusting screw and a scale, which shows the angle both in "degrees" and in "taper in inches per foot." The head and foot stocks are secured to the table by clamp bolts in a T-slot, which extends the whole length of the table and permits the movement of these stocks to any position.

THE GRINDING WHEEL.

As seen by reference to Fig. 2, the rear projection of the base supports the wheel-bed, on which is a sliding table, permitting the wheel to be moved backward or forward to suit the work. The wheel stand can also be rotated to set the wheel at any desired angle to the line between the centers which support the work. The angle is read off on a graduated semicircular arc on the lower edge of the wheel-bed. The wheel platen has a flat, circular bearing which gives a steady support for the wheel and prevents rocking. It may be adjusted to any position. For internal grinding the platen is turned around and an internal grinding fixture is placed on the end projecting over the swivel table. A heavy

wheel guard is bolted to the wheel stand, shielding the operator from sparks, dust and water.

Fig. 3 shows a section of the wheel stand and spindle. The latter is of hardened steel, ground and lapped. End play is taken up by the nut *a*, the set screw *B* acting as a lock nut. The boxes are 3 ins. × ⅜ in., and are of phosphor bronze. They are self-aligning, and may be adjusted by the nuts *C* and *D*. The driving pulley and flange are made in one piece. the box can be closed. The end thrust is taken up by a shoulder on the spindle, and a nut at the rear permits adjustment for wear. The spindle is made fast for dead center grinding by a thumb screw.

The head stock is provided with a pulley for driving the spindle and with large and small dead-center pulleys. Work may thus be ground in a chuck or fixture on the head-stock spindle, or upon two dead centers, or upon one dead and one live center. from 2,000 to 3,400 revolutions per minute, and the work may be run at 6 speeds, from 93 to 640 revolutions. The motion of the work is controlled independently of the wheel, so that work can be changed on the chuck or center without stopping the wheel. Thus the wheel is running at full speed when the grinding begins. Another time-saving device is a friction brake connected with the shipper-rod which starts or stops the work. When the

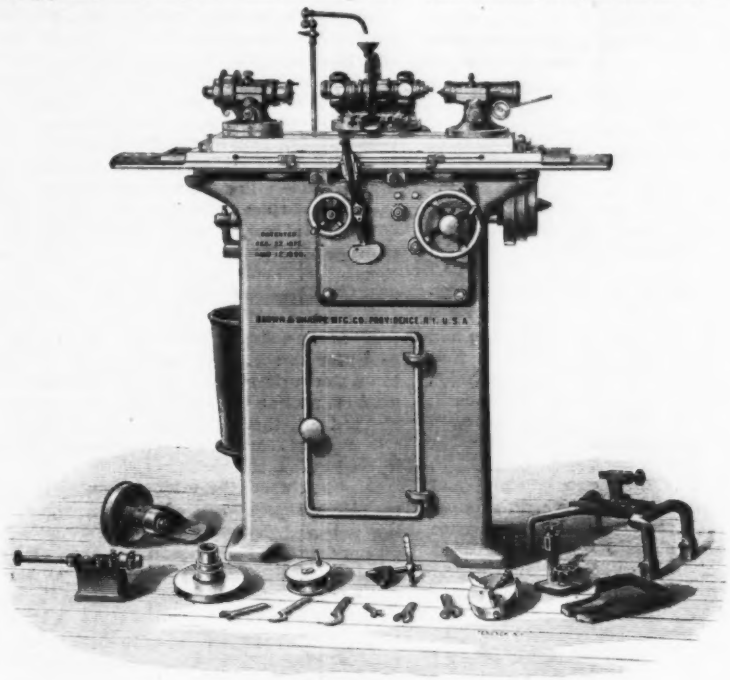


FIG. 1. Front View.

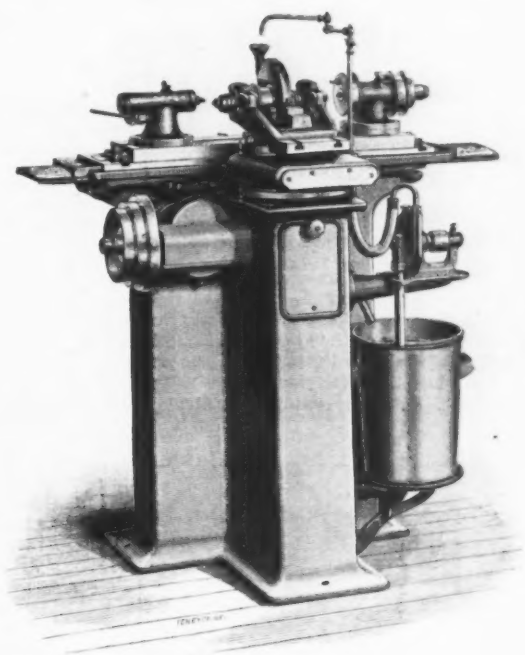


FIG. 2. Rear View.

PERSPECTIVE VIEWS OF BROWN & SHARPE'S NEW UNIVERSAL GRINDING MACHINE.

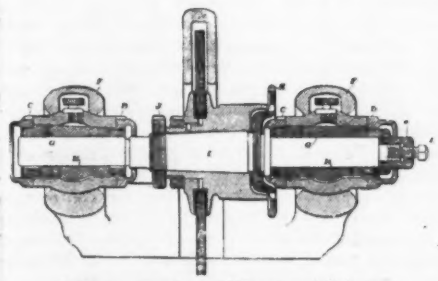


FIG 3 Section of Wheel and Spindle.

By grinding work on two dead centers, any possible inaccuracy in the spindle bearings does not affect the accuracy of the grinding.

The foot stock spindle, shown in Fig. 5, is quickly operated by a lever and the center is held up to the work by a stiff coil spring. By this means the spindle adjusts itself to the expansion of the work and the pressure between centers is kept practically constant. An oil reservoir is provided for oiling the centers.

OPERATING THE MACHINE.

To start the feed, the knob in the center of the large hand-wheel on the front of the machine is moved inward. This gives a positive connection, clutch is released the brake is automatically applied, and the work stops revolving almost instantly.

Throughout the machine great pains have been taken to make the fit and finish of all moving parts as accurate as possible by scraping to surface plates or grinding and lapping, and also to protect the bearings and slides from injury by dust. It is also intended that the machine shall be so firmly mounted and rigidly supported that all the parts may run at the highest speed without vibration.

The machine will take work up to 8 ins. diameter and 16 ins. length, and the table may be fed several inches beyond that length. The swivel table

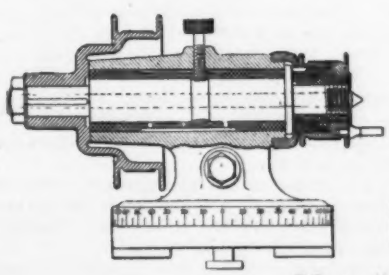


FIG. 4. Head-Stock.

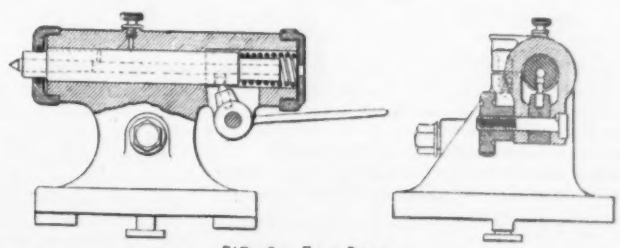


FIG. 5. Foot-Stock.

SECTIONS OF HEAD-STOCKS AND FOOT-STOCKS FOR BROWN & SHARPE'S UNIVERSAL GRINDING MACHINE.

The pulley is 2¾ ins. in diameter. It is fitted to the taper arbor at *I*, and is held in place by the nut *J*.

For wet grinding a pump is attached, as seen in Fig. 2. The pump is a simple fan revolving in a loose case, and the connections may be turned to deliver the water either upon the wheel or upon the work.

THE HEAD AND FOOT STOCKS.

The head stock swivels upon a central pin and has a graduated circle for setting to any desired position. Longitudinal and cross sections are shown in Fig. 4. The spindle is hardened steel, ground and lapped, and the boxes are of phosphor bronze. This makes it possible to run the spindle with the boxes tightly clamped upon it, which is necessary for accurate face and hole grinding. The screws *a* take up the wear and screws *B* limit the extent to which which cannot be disengaged by vibrations of the machine. The reversing of the table is done by a lever actuated by dogs, which can be set to any position, the same as dogs on a planer. For very accurate work, such as grinding up to a shoulder, the lever and its connections are cushioned so that the table is reversed without shock or jar. Another convenient arrangement permits the table to be moved by hand beyond the reversing points without altering the adjustment of the reversing dogs. The cross feed, by which the emery wheel is brought against the work to be ground, is operated from the front of the machine by a hand-wheel graduated to read to thousandths of an inch.

The overhead works consist of three shafts with tight and loose pulleys, 8 ins. in diameter for a 3-in. belt. The emery wheel may be run at any speed will turn so as to grind tapers up to 1½ ins. per ft. The wheel stand will take a wheel 7 ins. diameter and ¼ in. thick. The internal grinding fixture usually furnished will grind holes 5 ins. long and of ¾ in. or larger diameter.

The machine occupies a floor space 36 × 69¼ ins., and weighs, boxed ready for shipment, about 2,600 lbs.

A Floating Soil Distributor or Elevator.

A device for removing dredged material out of barges, invented by Mr. A. F. SMULDERS, of Utrecht, Holland, and used on the Baltic Sea Canal works, is described and illustrated in *Engineering* of Feb. 20.

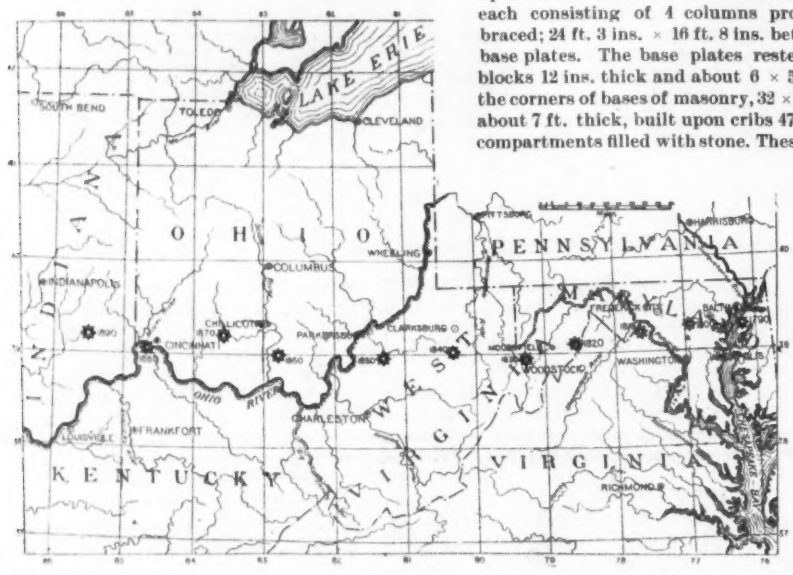
Two vessels, each 82 ft. long by 14 ft. 9 ins. wide, are placed parallel to each other and 21½ ft. apart.

They are held in this position by a connecting bridge at one end and the frame of a bucket tower which rests on both vessels near the other end. The barge to be unloaded is run into the middle space and under the tower, and a double chain of buckets, each of 5.65 cu. ft. capacity, lifts the contents of the barge about 42 ft. above the water surface and discharges the load into a suspended tube leading to the shore. As the bucket-chain travels at the rate of 25 to 30 buckets per minute, the two chains working together would double this discharge.

A compound engine of 150 HP. on one of the vessels operate two powerful centrifugal pumps which lift water to the dredged material in the chamber above and assist in washing this material to the point of deposit from the chute. The unloading capacity of this machine, in suitable soil, is 455 cu. yds. per hour. Four plants of this description have been built for use on the Baltic Sea Canal.

Movements of the Center of Population of the United States, 1790—1890.

The accompanying diagram, which we redraw from one which accompanies census bulletin No. 34, shows graphically one of the most remarkable facts in the history of the United States, viz., the persistent, way in which the 39th parallel, or, to speak more exactly, 39° 07.01′, has continued to divide the



MAP SHOWING POSITION OF CENTER OF POPULATION OF U. S. AT CLOSE OF EACH DECADE FROM 1790 TO 1890.

population of the United States into two equal parts. The extreme fluctuations from this line have been: 1830, 9.1′ south; 1790, 4.1′ north. Between 1790 and 1890 the line has moved only 4.6′ south, though during that period it has moved 505 miles west.

The successive westward movements of the center of population in each decade since 1790 have been:

Years.	North latitude.	West longitude.	West. movem't preceding decade, mile.
1790	39° 16.5′	76° 11.2′	..
1800	39 16.1	76 56.5	41
1810	39 11.5	77 37.2	36
1820	39 5.7	78 33.0	50
1830	38 57.9	79 16.9	39
1840	39 2.0	80 18.0	55
1850	38 59.0	81 19.0	55
1860	39 0.4	82 48.8	81
1870	39 12.0	83 35.7	42
1880	39 4.1	84 39.7	58
1890	39 11.9	85 32.9	48

The center of area is in northern Kansas, lat. 39° 55′, long. 98° 50′.

The so called "center of population," however, is not precisely that, though near enough to it for all practical purposes. It is rather the center of gravity of population, in which a man living 1,000 miles from the "center" has 10 times as much "moment" or influence upon the position of that center as one who lives only 100 miles from it. Hence every settler on the Pacific coast has three or four times the weight to move the center westward as one on the Atlantic coast has to keep it eastward. Hence the true "center of population, as distinguished from the center of gravity of population," is considerably to the eastward, and also to the northward, of the center of gravity shown on the map. How much we cannot say; it would have been well had both centres been determined, though it is obvious that the "center of gravity," as shown on the map, is the more significant of the two.

A Coffer Dam or Caisson without Timber or Iron in Its Construction.

The following is an abstract of an interesting paper by Mr. Robert L. Harris, M. Am. Soc. C. E., which was read at the meeting of the Society on March 4:

During the winter of 1888-89 the New York & Northern Ry. Co. determined to replace the iron bridge crossing Croton Lake with a heavier structure, and the writer was called upon to attend to the matter. The bridge existing in 1888 was a single-track, wrought-iron deck structure of 3 spans of 150 ft. each; total length about 480 ft.; depth of trusses c. to c., 24 ft.; width c. to c. of trusses, 13 ft. These spans rested upon skeleton rolled-iron towers, 41 ft. 7 ins. high, each consisting of 4 columns properly tied and braced; 24 ft. 3 ins. × 16 ft. 8 ins. between centers of base plates. The base plates rested upon granite blocks 12 ins. thick and about 6 × 5½ ft. in area, at the corners of bases of masonry, 32 × 22 ft. in area and about 7 ft. thick, built upon cribs 47 × 35 ft., with 9 compartments filled with stone. These cribs were composed of 4-in. plank, gained 1 in. and bolted together; and around the cribs had been placed some rip rap. The depth of water at the southerly crib is about 18 ft., at the northerly crib about 28 ft. These cribs and masonry bases were built about 1869 by the New York, Boston & Montreal R. R. Co., which failed just before an iron bridge was to have been erected. In 1879 the deck bridge mentioned was erected by Mr. A. P. Boller, M. Am. Soc. C. E., and did good service until its removal, in 1889.

The masonry did not awaken suspicion upon preliminary examination, especially as it was old masonry, fully pointed (but some stones "quakered"), upon crib foundations that had been in place under water 20 years. It was thought it would only be necessary to add more rip-rap outside the cribs, and build piers of masonry within the skeleton towers upon the old masonry bases. The weight upon the bed plates had been over 17 tons per sq. ft. The extreme load of the proposed structure, applied within the area of the skeleton towers at top of the bases, would be under 3 tons per sq. ft., which could be delivered at the crib at less than 2½ tons per sq. ft. An examination showed that the bases of masonry above the cribs could not be depended upon. The roofs and sides were but thin shells, inclosing large and small stones, bowlders, earth and rubbish. Mr. A. P. Boller told me of his experience in 1879 at the same place, and gave me a copy of the Transactions Am. Soc. C. E. for April, 1882, in which he related the ingenious manner in which he surmounted a difficulty. He told me I could rely on the masonry corners, which he had rebuilt upward from the crib.

It was decided, as the iron spans were being built, and as the corner compartments of the cribs had carried the old weights so many years, to continue on the general plan, and begin the new work from near the crib, it being judged that a distribution of the increased weight over so large an area of the crib as possible would be sufficient. A mass of rip-rap having a berme of 7 to 10 ft. at the top of the crib and a slope of 1¼ to 1 was first placed around each crib. The tops of the cribs were about 7 ft. below the top of the bases, or only about 5 ft. below water, just sufficient to require diving appliances or a coffer dam or caisson of some kind, in order to remove the interiors of the bases with extreme care. We removed all of the middle that we dared by hand, chains and grapples, but the water was too muddy to permit of careful work at the sides, ends or corners. The bottom of the lake was irregular and with many bowlders. Various expedients were considered and rejected, such as forcing sheet-piling through the rip-rap, covering the entire surface of the rip-rap with tarpaulin, etc. After careful consideration I determined to use the materials that were in place, and make a caisson therein without disturbance, by cementing, for the floor of the caisson, a portion of the loose mass of irregular stone-filling in the crib at any level below the top of the crib; and for walls, to cement from thence to the water surface, or as high as necessary to make good connection with the shell. This could then be pumped out, the interior carefully excavated to the crib, and the space filled with concrete rammed in layers to the top of the old shell.

The track upon the bridge was over 75 ft. above the crib, and grout was mixed upon the track over the crib and delivered directly through a hopper, pipe and nozzle, but the plan was soon changed to pumping in the grout immediately at the base. Holes were pushed and worked among the stones to a few feet below the top of the crib. A long nozzle of 1½-in. iron pipe, connected to the discharge pipe of a No. 2 Douglas hand force-pump, was inserted in one of these holes to its bottom, the water was rapidly pumped through for a few minutes, then the suction hose was suddenly transferred to a reservoir of grout, composed of Alsen Portland cement and fine sharp sand in equal parts, mixed immediately before use; two or three barrels only of the grout were slowly forced through, and the nozzle was then withdrawn, but the hole maintained, and the same operation was proceeded with at other holes, seldom returning to any hole on the same day, my belief being that in quiet water the cement would accrete on the surface of irregular stones at and below the level of injection, and that by consecutive slight accretions the voids between them would be filled. After repeating these operations for several days, the water was pumped out by an Edwards centrifugal pump with 6 in. discharge, and we proceeded with the excavation to the crib with so little water that at times a single man at the hand pump kept it free; and then put in very rich béton, composed of Alsen cement 1, coarse sharp sand 1, broken rock 4, in solidly rammed layers of 9 in. thickness. During the excavation we found, at 6 ft. away from the nearest nozzle holes, sharp-edged stones upon whose acute angles there were accretions of cement over ½ in. thick.

I had made a cemented caisson or coffer dam in water reaching to a short depth below the top of the crib, using the loose stones there in place. Close observation during the operations failed to show loss of cement into the lake through the outside of the rip-rap; this is accounted for by the care exercised in forcing slowly but a little grout at a time at any one hole, and in giving it time to accrete upon the stone before another charge was applied. The same plan, somewhat improved, was employed at the other pier in 28 ft. of water without serious trouble. Trains were running regularly, though at low speed, over the spans resting on the iron legs supported by the four almost isolated corners of masonry. Upon the concrete filling were reared the new piers, a little over 40 ft. in height, the bases of which were about 22 ft. 10 ins. × 15 ft. 4 ins., each narrowing at 8½ ft. to a shaft whose base is 20 ft. 7 ins. × 9 ft. 3 ins. and the top under coping 18 × 6 ft 9 ins., surmounted by a coping 19 × 7 ft. 6 ins., 18 ins. th ick. These support three deck spans of 156 ft. 9 ins. c. to c.; depth of trusses c. to c., 25 ft. 4 ins.; total height from base of bed plate to base of rail, 27 ft. 11 ins. The trusses are 13 ft. between centers. These spans were designed by Mr. Theodore Cooper, M. Am.

Soc. C. E., and were manufactured and erected by the Passaic Rolling Mill Co., of Paterson, N. J.

The process can be used with rip-rap, rubble, coarse gravel, mud, sand, and even quicksand by the use of proper precautions. It affords a simple and convenient mode of making coffer dams, caissons, breakwaters, shore protections ,etc., using largely the materials at hand or in place; and is especially useful in enlarging, repairing and strengthening sub-aqueous structures, while it may also be used in solidifying some kinds of materials for subterraneous structures, as tunnels, shafts, etc., and the enlarging of bases for foundations upon unstable materials.

In the discussion Mr. MACDONALD referred to cases in which bridge piers had been successfully built upon a foundation of broken stone or rubble. In one case a crib being sunk in 40 ft. of water for the Lehigh Valley R. R., encountered a sunken canal-boat at about 10 ft. from the bottom; sinking was stopped, broken stone filled into, under and around the crib, and the bridge pier then built on top. Other examples of the use of broken stone for foundations, fills, etc., were mentioned. The repair of canal walls at some of the mills at Holyoke, Mass., by forcing in grout was also referred to, and Mr. WORTHEN stated that he had strengthened a wooden flume by forcing cement grout under it, through holes over the hollow parts. He had also used sand for filling in dry masonry with good results. Mr. HARRIS stated that the point he wished to make was that cement was not used as in ordinary grouting, but by successive injections of small quantities, and allowing it to settle, the spaces would be filled by the gradual accretion of the cement on the stones.

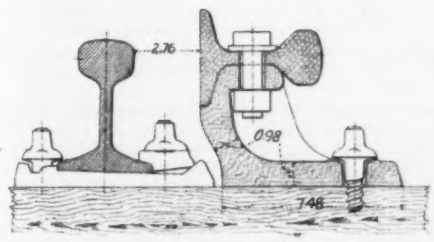


Fig. 4. Section E F.

Bridge Guards Used on the State Railways of Holland.

In a recent number of the *Organ des Eisenbahnwesens*, Mr. J. W. POST, Chief Engineer of the State Railways of Holland, contributes an interesting article on the necessity of bridge guards. Much of the matter is similar to articles that have appeared in this journal from time to time, and the guards advocated for, and partially adopted on the Dutch railways are only modifications of the familiar Latimer type, as shown in the accompanying illustrations.

Mr. POST uses 7 steel or wooden ties where the ballast is coarse sand, and attaches a steel plate to them by steel screws, as shown in Fig. 1. On this plate, which forms a floor for the derailed wheels, is placed the rerailing device.

The necessary elevation is obtained by inclined planes, inside and outside the track. These planes are formed by blocks, the thinnest being forged and the others cast. They are shown in longitudinal section in Figs. 2 and 3.

Where, in the plan, the distance between the guard and main rails is too small to allow the wheel to pass, the inclined plane has already reached its highest point, which is 0.8 in. below the top of the rail, as shown in Fig. 2. Since the flange is from 1 to 1.2 ins. high, the tread of the wheel will then be at least 0.2 in. above the rail. The blocks diminish in height from this point on, and the tread is thus brought into place.

Fig. 3. Section A B.

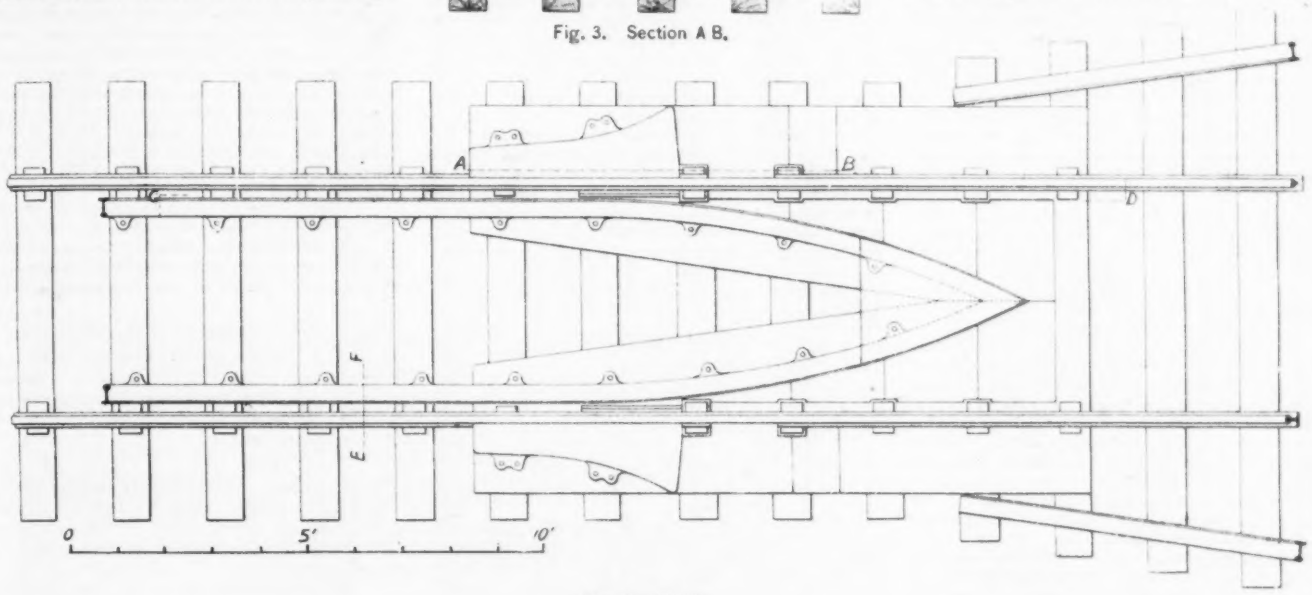


Fig. 1. PLAN.

Fig. 2. SECTION C D.

The derailed wheel outside the track runs up a steeper incline in order that its flange may be drawn over the rail to the proper position. The top of this incline is 0.4 in. below the rail, since provision must be made for worn ties and rails. Otherwise the blocks and rail would be given an equal elevation.

Running the whole length of the bridge are two guards, formed by old rails laid in special castings, as shown in Fig. 4, and outer guard rails are provided at the two ends, as indicated in Fig. 1.

The Properties, Uses and Processes of Production of Aluminum.*

(*Concluded from p. 202.*)

CLAY AS A SOURCE OF ALUMINUM.

Evidently contrary to the understanding of the case by many people who have written us with brilliant claims of rich mines, aluminum has never been found in nature in the metallic state; and yet the general statement made by Prof. RICHARDS is true, that "there is no other metal on the earth so widely scattered and that occurs in such abundance." This statement, however, has been interpreted by the public to the effect that therefore all these varied minerals containing aluminum are equally applicable as ores from which to extract the metal; especially have they considered that clays, silicates of aluminum, are the specially chosen ores for the production of aluminum. A consideration of the comparative constituents of clay with those of the minerals given below shows the disadvantage of the richest of clays, as aluminum ores as compared with the richer and purer oxides, fluorides and sulphates, which minerals are now used as ores of aluminum.

Bauxite ($Al_2 H_6 O_6$), soft and granular; with 50% to 70% oxide of aluminum and with only a few per cent. of accidental impurities besides the water of hydration.

Corundum (Al_2O_3), very hard and crystalline, specific gravity 3.909.—With 93% alumina and ordinarily very free from impurities, but so hard and crystalline and withal so valuable for other purposes as not to be at present used as an aluminum ore.

Diaspore ($Al_2O_3H_2O$), hard and crystalline; specific gravity, 3.4.—With 65% to 85% alumina and ordinarily very pure.

Cryolite ($Al_2 Fl_6 6 NaFl$), specific gravity, 2.9.—With 40% aluminum fluoride and 60% sodium fluoride.

Aluminite ($Al_2 SO_6 9H_2O$), specific gravity, 1.66.—Containing some 30% of alumina in a condition by solution, filtration and roasting to be cheaply purified.

Gibbsite ($Al_2O3 3 H_2O$), stalactitic; specific gravity, 2.4.—Containing about 65% alumina.

In comparison to these, the clays vary from tri-basic silicates of alumina to pentacid silicates, minerals with at best 65% alumina and 35% silica; while the more common clays contain from 50% to 70% silica and only from 50% to 35% alumina. Pure kaolin contains 39% alumina, carrying about 20% aluminum, with 40% silica, and 14% water. Now silica is much easier reduced than alumina to aluminum, and by all the methods of reduction this large percentage of silica must be separated from the alumina before the reduction is commenced, else a large percentage of energy used in reduction will be expended in reducing a troublesome impurity instead of in reducing the alumina to aluminum. The true value of clay as an ore of the metal is evident, therefore, in comparison with the richer and purer ores that have only accidental amounts of iron and silicon up to perhaps 10%, to be removed before being submitted to the reducing operation.

There seems to be one fact favorably prominent, however, in the prospect of fat clays like the kaolins being used as aluminum ores—that is, that concentrated cold sulphuric acid dissolves the alumina out of most clays, leaving the silica insoluble. Although this fact has not yet, to my knowledge, been made use of on a commercial scale; still, in the future, when there is a large demand, this method may make clays available as ores of aluminum.

PREPARING ALUMINUM ORE FOR REDUCTION.

Bauxite is the mineral most used at present for the manufacture of alumina, and it probably will continue to be the most economical ore, for the reason that it is soft, easily ground and easily decomposed to separate the impurities of silica and iron. The mineral occurs in great abundance in the South, in Tennessee, Virginia, North and South Carolina, Georgia, Alabama, and also Arkansas. Very pure bauxites can be laid down in quantities in Pittsburg at a cost of between $9 and $10 per ton, and with only the cost of mining and transportation can be put on cars nearest the mines in many cases at a cost of less than $2.50 per ton.

The general method of purification of the ore is to calcine the bauxite with just sufficient sodium carbonate to form sodium aluminate ($Al_2O_3 3Na_2O$). The temperature must be kept below the melting point (the aluminate

* A lecture by ALFRED E. HUNT, President of the Pittsburg Reduction Co., before the Boston Society of Arts.

being formed at a temperature lower than the melting point of the mixture), else sodium silicate will be formed. The mass is well stirred to insure the complete displacing of all the carbonic acid and the combination of the sodium carbonate with the alumina. A ready test of the completion of the reaction is that portions taken from the mass no longer effervesce and evolve carbonic acid upon treatment with acid. The incinerated mass is taken out of the furnace, ground and lixiviated with hot water, which takes the sodium aluminate into solution, leaving the silica and iron insoluble. The clear supernatant sodium aluminate solution is siphoned off, and the alumina is precipitated with carbonic acid gas. This forms sodium carbonate, which remains in solution, while the alumina settles out to the bottom of the tank. This is afterwards washed with hot water and dried.

The same general method of treatment is applicable to the aluminum oxide minerals for their preparation; the difficulties to overcome being in grinding the minerals, because of their hardness and the formation of the sodium aluminate at a low enough heat to prevent the sodium silicate forming. It may be that these minerals had best be taken into solution as sulphates and thereafter treated as the native sulphates by a red heat to drive off the sulphuric acid, leaving pure alumina as a residue. With proper apparatus to condense and save the sulphuric acid, such processes may not be excessively expensive. However, neither this method of manufacture of the sulphates from clays or from native oxides, nor the method of manufacture of alumina from the sulphate by roasting, have so far found favor commercially in comparison with the soda carbonate fusion method for the preparation of the oxide. The sulphate of aluminum melted with sulphur gives off sulphuric acid gas and transforms the alumina into sulphide. This reaction has been made available in one of the methods of manufacture of aluminum from sulphide by the aid of electricity; the sulphide being afterwards decomposed by electrolysis.

COMPOUNDS OTHER THAN ALUMINA FROM WHICH ALUMINUM HAS BEEN REDUCED.

Aluminate of soda is made from cryolite by the incineration of finely ground cryolite with an intimate mixture of chalk or finely ground carbonate of lime, with enough ground coke to keep the mixture porous. Soluble aluminate of soda is formed; insoluble fluoride of lime remains as a waste product. The precipitation of the alumina from the aluminate of soda is carried on by the same method as previously described.

Aluminum sulphide, a yellow, infusible salt, containing 36% aluminum, is produced from alumina by the reaction of carbon bi-sulphide at a high heat in the presence of carbon. It is also prepared, as explained, by the fusion of aluminum sulphate in the presence of sulphur. It is a rather unstable compound, being decomposed by standing in moist air into alumina, with the evolution of sulphuretted hydrogen.

The chloride of aluminum was for a long time the chief salt from which the metal was produced, for the reason that it had been found that metallic sodium reduced the metal from this salt the easiest. For a long time, the only practical way of cheapening the manufacture of aluminum by this method was to cheapen the manufacture of sodium and reduce the expense and improve the quality of the aluminum chloride. This proved a difficult task.

The salt varies from pure white, when pure, through the yellows to a brick red when largely contaminated with ferric oxide. It is produced by the action of chlorine gas upon an incinerated mixture of alumina with tar or some oil that will, on burning out during the incineration, leave its coke in intimate mixture with the alumina. The double chloride of aluminum with sodium is produced, if a supply of salt is added to the mixture and it is treated with chlorine gas. The expense and difficulties connected with the manufacture have proven very large, and the chlorine produced has to be very carefully made to keep it free from iron. The difficulties counected with the generation and use of chlorine gas on a commercial scale are found to be very great and the deterioration of the apparatus to be very serious.

The native fluoride of aluminum and sodium, the mineral cryolite, has been used in several processes as the ore for the production of aluminum. It, however, contains too much silicon and oxide of iron to make pure metal; for, as before said, in all the methods so far devised, or which seem likely to be devised in future, the agents that serve to reduce the aluminum to a metallic state will surely reduce all the silicon and iron from their oxides that may be present at the same time or rather previous to the reduction of the aluminum. Pure aluminum fluoride (Al_2F_6) is produced by the action of sulphate of aluminum on cryolite, sulphate of soda being the by-product, according to M. GRABAU. Aluminum fluoride can also be produced by the action of hydrofluoric acid on alumina. It is not such an expensive or difficult salt to prepare as the chloride, and is the compound from which aluminum is produced in many of the later and more successful processes. Metallic sodium reduces the fluoride of aluminum with the same facility with which it acts upon the chlorine compounds.

METHODS OF ALUMINUM MANUFACTURE.

Aluminum cannot be reduced from its oxide by the aid of carbon as a reducing agent, because the temperature to which the intimate mixture of the solid carbon and the alumina has to be raised can only be attained by the highest heat of an open-hearth furnace or in the electric furnace—a temperature at which the aluminum reduced cannot itself be accumulated into a molten liquid mass, and can only be retained by cloaking it with a more stable metal like iron or copper. It is for this reason that the Cowles Electric Smelting & Aluminum Co. are not able in their electric furnace to manufacture commercially pure aluminum, nor the Heroult people to manufacture the metal from their process of reduction, where they electrolyze pure molten alumina, which requires a high electrically produced heat to melt the oxide. None of the other salts are susceptible of being reduced by carbon at much lower temperatures than the oxide, so far as yet discovered.

Debarred from using carbon as the reducing agent under the ordinary conditions which make it the practicable and economical reagent in most metallurgical operations, the advantages of other stronger reducing agents have been carefully tried. So far only one has proven commercially available, although there are many other agents capable of reducing the metal from its oxide. Metallic sodium reduces the metal from its chloride or from its fluoride salts with ease. Methods based upon the use of sodium as the reducing agent have until lately given not only the purest but the cheapest aluminum. These methods, however, of late have been succeeded by the cheaper and more direct processes of electrolysis of some of the aluminum salts or of the pure oxide.

THE HISTORY OF ALUMINUM PRODUCTION.

So far as history informs us, WÖHLER in 1827 first reduced metallic aluminum by the aid of metallic potassium as the reducing agent from aluminum chloride. The metal was a dry powder in a finely comminuted state; it was very impure, and was only a metallic curiosity. DEVILLE, 27 years later, in 1854, was the first to produce the metal in any quantity or with any degree of purity.

It is curious to note that the first pure aluminum made was by electrolysis; both BUNSEN and DEVILLE reduced the double chloride of aluminum and sodium by electricity generated by galvanic batteries. But as at that time the dynamo was still a machine of the future, electrolysis was soon abandoned for the sodium process by the successful concerns in the manufacture of the metal, although continued experimental efforts were made with electricity from that time to this. The first aluminum made in 1855 was valued at $90 per lb. In 1857, with the development of the sodium method of reduction, the price was lowered to from $28 to $32 per lb. In 1860, the price was again lowered to about $17 per lb., and from 1862 to 1887 the price ranged from $12 per lb. upward, according to purity. In 1887 the price was reduced to one pound sterling per pound avoirdupois; and it was at this price that the first metal made was sold by the new concerns built during that year. In 1889 the Pittsburg Reduction Co. reduced the price to $2 per lb. As the English works of the Pittsburg Reduction Co. commenced in 1890 to sell the metal in England at five shillings ($1.21) per lb., I presume that future writers will record a further drop in the price of the metal in 1891.

About 1857 the famous works at Salindres were established that, which the proprietorship of Pechiney & Co., for many years and, in fact, until within the past three years, enjoyed not only the reputation of making the best but the largest amount of aluminum produced in the world. The care and skill shown, and the ingenious devices and precautions taken by the firm to prevent impurities in the metal in the cumbersome and expensive sodium process in which there were so many opportunities for the addition of impurities, were worthy of the highest praise. In 1860 Sir I. LOWTHIAN BELL, with a brother, started a works in Newcastle on Tyne, which was abandoned in 1874. They manufactured by the sodium process. From 1874 until 1882 the French company at Salindres was the only concern making pure aluminum.

In 1882 WEBSTER organized the "Aluminum Crown Metal Co." at Hollywood, near Birmingham, in England, and by cheapening the production of aluminum chloride soon developed a successful concern. This was further strengthened by the improvement of Mr. H. Y. CASTNER, an American chemist, who, in 1886, patented improvements for producing a more intimate mixture of the carbon with the caustic soda in a state of fusion by means of a carbide of iron, in this way cheapening by more than one half the cost of manufacture of metallic sodium, which had been $1 per lb. This concern was organized under the name of the Aluminum Company, Limited, and put up a large and expensive plant at Oldbury, near Birmingham, England. These works were started at the end of June, 1888, and they have been manufacturing up to within the past six or nine months. In common with the other manufacturers by the sodium process, they have been working at great disadvantage since the advent of the more successful electrolytic processes.

Early in 1888 the Alliance Aluminum Co. started a works at Wallsend-on-Tyne, England, which was an innovation upon the DEVILLE sodium process by using the fluoride or the double fluoride of aluminum and sodium cryolite as the compound to be reduced instead of the chloride or the double chloride of the metal. Professor NETTE, the managing director of the concern, also had a process for producing metallic sodium cheaply by allowing fused caustic soda to trickle over incandescent charcoal in a vertical retort. Some very excellent aluminum was produced at this works; they became involved in a lawsuit, however, with the Aluminum Co., Ltd., and the newer processes coming up caused them also to close their works, which have now been shut down for over a year.

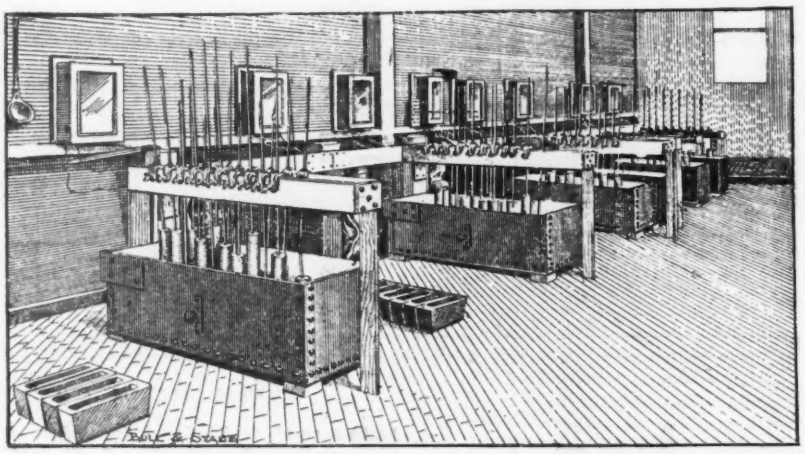
ALUMINUM PRODUCTION BY ELECTRICITY.

In spite of the broad claims of the Cowles Bros. to the use of electricity for metallurgical purposes, the first actual reduction of aluminum in a metallic state on a practical scale by DEVILLE in 1854 was, as we have seen, by the aid of electricity, electrically decomposing the chloride. Even then the idea was old, for Sir HUMPHREY DAVY in 1810 publicly described the successful experiment made in 1807, in which he connected the negative pole of a battery of 1,000 double plates with an iron wire which he heated to a white heat and then fused in contact with moistened alumina, the operation being performed in an atmosphere of hydrogen. The iron upon analysis was found to be alloyed with aluminum.

BUNSEN in Germany and DEVILLE in France, in 1854, each electrolyzed the double chloride of aluminum and sodium. LE CHATELIER obtained English patent No. 1,214 in 1861, and MONCKTON, in 1862, English patent No. 264 for the reduction of aluminum by aid of electricity. In fact, RICHARDS says that the Monckton patent "proposes to pass an electric current through a reduction chamber, and in this way to raise the temperature to such a point that alumina will be reduced by the carbon present," showing that not only was the use of electricity for reducing aluminum old, but that the idea of the electric furnace was 20 years old at the date of the first of the Cowles patents in 1885.

RICHARDS in his work on aluminum mentions and gives the published authority in each case of the processes for reducing aluminum with the aid of electricity; of GAUDIN, 1859; KAGENSBUSCH, 1872; BERTHAUT, 1879, and GRATZEL, 1883.

The newer pure aluminum processes using electricity of HALL, HEROULT and the BERNARD brothers, with the help of MINET, together with the alloy processes of the COWLES brothers and of HEROULT, are the only ones that are now being worked upon a commercial scale, so far as I know, though perhaps the meritorious inventions of Mr. GRABAU may have been reduced to practical working of late. Of this I am uncertain, or of what is being done by Herr SAARBURGER at Hemelingen, near Bremen. I only know that we no longer hear of the Aluminum & Mag



REDUCING POTS IN THE ALUMINUM PRODUCING PLANT OF THE PITTSBURG REDUCTION CO.

nesium Fabrik Co.'s aluminum in the competition of the markets, nor of any metal made by the sodium process.

Besides these, there have been a host of other electrical attempts and experiments for the manufacture during the past two years, since the success of some of the other companies using electricity became known.

THE HALL PROCESS OF ALUMINUM PRODUCTION AND OTHER ELECTRIC PROCESSES.

The Hall process of manufacturing aluminum is owned by the Pittsburgh Reduction Co., who have, in addition to 300 electrical HP. at work in Pittsburg, another plant of about equal size at Patricroft, Lancashire, England; the Pittsburg works commencing to manufacture in November, 1888, and the English works in July, 1890.

The Hall process consists in electrolyzing alumina dissolved in a fused mixture of fluorides of aluminum and sodium or of fluorides of aluminum and potassium, or, in fact, Mr. HALL has covered in his letters patent No. 400,667 a fused bath in which the alumina is dissolved in the fluoride of aluminum, together with the fluoride of *any* metal more electropositive than aluminum.

As the Pittsburg Reduction Co. uses the process, it places the mixture of fluoride salts in a row of carbon-lined iron tanks placed in series. [We reproduce a cut from our issue of Nov. 8, showing the reducing pots.—ED.] The pots, together with their carbon linings and the reduced metal in the bottom of the pots, become the negative electrodes or cathodes. The positive electrodes or anodes are a series of 3-in. diameter carbon cylinders, attached by ⅝-in. copper rods to the copper conductors by the aid of suitable binding screw clamps. The current of 5,000 amperes and 50 volts in one series, and of 2,000 amperes and 20 volts in the other series, is turned on, and the mixture is melted by the heat caused by the resistance offered to the current by the fluoride mixture. In two hours' time the mixture becomes fluid, and alumina is added. The electrolyte then becomes a much better conductor, "the resistance of the pot" goes down to a normal one of about 8 volts, and the operation of electrolysis commences. The alumina in solution, or, as some claim, the fluoride of aluminum, is decomposed; the metal, being heavier than the electrolyte, sinks to the bottom of the pot, and the oxygen goes to the positive carbon electrode, uniting with a portion of the carbon and escaping as carbonic acid gas; or, as is maintained by some, the aluminum of the fluoride of aluminum is deposited and the fluorine attacks the dissolved oxide, reforming fluoride of aluminum, and thus maintaining the integrity of the original electrolyte bath, the oxygen going off as in the other case at the positive electrode.

While the actual fact as to which reaction takes place is not essential to the validity of the Hall patents, and the Pittsburg Reduction Co. makes no claims regarding the matter, it is our belief that the compound electrolyzed is alumina. I may say in this connection that this is the view of Prof. J. W. LANGLEY, Professor RICHARDS, and of all of the other metallurgists who have had experience with and have given the actual metallurgical operations careful study.

Among the reasons for our belief are the heat of formation of alumina, 391,600 calories; the fact that it requires only 2.8 volts to decompose it; the probable fact that the formation of the aluminum of fluoride is very considerably greater; the fact already established that it requires a very much higher voltage than 2.8 to decompose the electrolyte that we use; and the fact, already mentioned, that when the bath gets out of alumina the resistance rises considerably (ordinarily about four volts), and that the heat rises rapidly in the pot until the electrolyte itself begins to decompose and stifling white fumes of hydrofluoric acid begin to be given off.

According to my understanding of the case, the difference between the Hall process and the Heroult alloy process is this: Hall electrolyzes alumina made fluid at a lower temperature by dissolving it mechanically in a fused fluoride solvent, lighter than aluminum, which will not corrode the metal, and above all will not be itself decomposed by the electric current (or at least will not stay decomposed), and which is a sufficiently good conductor of electricity to allow the temperature of the molten bath not to reach much above the melting point of the metal. In the Heroult process they electrolyze alumina made fluid by the intense heat of the electric arc, at a temperature at which the metal has to be protected by being alloyed with copper or iron in order to retain it.

DETAILS AND ADVANTAGES OF THE HALL PROCESS.

In the practice of the Hall process, the heat is retained in the molten bath by a covering of finely powdered carbon on the surface of the molten mixture. On top of this carbon raft the powdered alumina is placed, and when the voltmeter attached to each pot shows a rising resistance, the pot tender stirs in more heated ore from the surface of the pot. The carbon soon comes to the surface, when a fresh supply of ore is placed on it. The feeding is thus easily made continuous, and as the electrolyte remains constant it only requires tapping the metal off—or, as is rather crudely, but very satisfactorily done, dipping the metal out in cast-iron ladles, skimming the electrolyte back into the pots with the carbon rods—to make the entire operation continuous. The pots are run for months at a time. The following are the chief advantages of the continuity of the process:

1. *Purity of the Metal.*—After the first run of metal is cast, carrying with it all the iron and silica, or rather the reducible impurities of the electrolyte, the only other sources of impurity are in the pure alumina added and in the ash of the positive carbon electrodes, which are worn away in the proportion of a little less than weight of carbon to the weight of metal produced.

2. *Saving of Material.*—The loss of metal and ore in a finely divided state in the bath, which occurs when a shut-down is required, is avoided. To be sure, this loss can be largely avoided by re-melting again; but in melting down the metal in a finely comminuted state it is found to be almost entirely redissolved. As continuously carried on, the loss of metal is practically nothing, every particle being reduced; undoubtedly it is often reduced more than once by being redissolved before settling through the bath to the metal below, when the ore gets out of the electrolyte and it becomes acid. At the same time, as there is no slag or other waste product, solid or liquid, evolved, and as the gases can carry off none of the aluminum, all of the aluminum in the ore added is finally brought out in ingot metal, a result that is seldom experienced in the reduction of metals from their ores.

3. *Economy.*—The original heat of the electrolyte is constantly maintained, and the only supplies needed are the constant electric current, the alumina ore and fresh carbon electrodes to replace those worn out, with only occasional additions of fresh electrolyte to replace the small loss of that taken out with the ingot metal or that which has become decomposed by the workmen carelessly letting the pots get out of ore. This decomposition of the electrolyte means an infusible "cake," as the workmen call it, settling to the bottom of the pot and filling it up. When the pots are not skillfully run or more easily decomposing electrolyte mixtures are used, this accumulation is what shortens the run of the pot, and also decreases the output. In the regular practice of the Pittsburg Reduction Co. there is practically no decomposition of the electrolyte, and a pound of aluminum is made with an expenditure of about 22 electrical HP. per hour.

This electrical energy expended in heat is not very expensive. Supposing water power to be used at a cost of $12 per HP. per annum, allowing 25% for loss in converting mechanical into electrical energy, and supposing 75% of this energy to be converted into heat, Professor RICHARDS has calculated the heat generated by 1 HP. during one year as 8,400,000 heat units.

The Hall process can be successfully carried on entirely independent of carbon, using a thick iron or copper tank, and either iron or copper electrodes. The deposition of the metal is nearly as large as with the use of carbon electrodes; but it is, of course, alloyed with copper or iron from the metal worn away from the positive electrode.

The Pittsburgh Reduction Co. has made alloys of aluminum with iron and copper by this process similar in character to the alloys produced by the Cowles and Heroult alloy processes.

THE HEROULT AND MINET PROCESSES.

Almost at the same time that HALL invented his process for manufacture of aluminum, in the early part of 1886 (his first patent application dating July 9, 1886), M. PIERRE HEROULT commenced operations and afterwards took out English patent No. 7,426 of 1887 for fluxing alumina with cryolite. The bath was put into a graphite crucible, which served as a negative electrode, and this was put inside a larger crucible, the space between the two being filled with graphite, and the carbon positive electrode being immersed in the fused bath. The ideas of M. HEROULT and Mr. HALL at the start were very nearly identical. M. HEROULT attempted to obtain an American patent and was declared in interference with HALL; and, after the testimony as to dates of invention and of the application for patents, M. HEROULT withdrew in favor of Mr. HALL. This process was practically abandoned for a while by M. HEROULT in favor of his very successful alloy process of electrolyzing and reducing molten alumina; but since 1889, when a growing demand sprung up for pure aluminum and the success of the Hall process became known, I understand that two concerns have begun working under the same principles, the Aluminum Industrie Actien Gesellschaft, at Neuhausen, Switzerland, and a concern at Froges (Isere) in France, called the Société Electro-Metallurgique de France. I have seen some very pure and excellent metal from the Swiss concern.

The process commonly called "the Minet Process," as developed and used at the works of the Bernard Brothers at Creil, Oise, France, consists in electrolyzing a mixture of sodium chloride with aluminum fluoride, or with the double fluoride of sodium and aluminum, their English patent dating July 18, 1887, No. 10,057. This company, I understand, have been doing successful work, and are now putting aluminum on the market of good quality. Thus it will be seen that there have developed apparently three separate electrolytic processes for the manufacture of pure aluminum at about the same time, all of which are working on about the same lines. These, together with the already much-written-about Cowles and Heroult processes for the manufacture of aluminum alloys, have for the past two years distanced all competitors manufacturing by the aid of metallic sodium, and are to-day in the possession of the aluminum market of the world.

FUTURE PROCESSES OF ALUMINUM PRODUCTION.

And now I will close with a few remarks upon the prospects and possibilities of the future—a subject in which, as President of the Pittsburg Reduction Co., I am both financially and technically very much interested.

First, let me preface what I have to say by stating that I am not at all afraid of any new process of which the first we hear is the blast of trumpets and a general outcry through the newspapers of the very low cost at which the metal can be made, given in figures exact to a cent. I feel confident that either the inventor of such a process or his friends, the company promotors, have so little sagacity and business sense that they will fail even if they have a good thing; or else that they are simply attempting to further deceive the public and prospective investors with delusive prospects, which, if well founded, would have been the very reason for keeping the matter quiet until they had become organized, secured their capital and protection, so far as possible, by letters patent. If an inventor has a meritorious process for the manufacture economically favorable to the processes now in vogue, the method would have to be so simple that he would be able easily to prove it, and then he would have no trouble in securing capital to help him. The first thing any sagacious capitalist would then do would be to insist that cost prices be kept quiet, at least until it should be proved on an actual manufacturing scale just what cost prices were. For very often a most delusive difference is found to exist between the theoretical cost price and actual cost price, as may be proved by the books of almost any well organized manufacturing concern.

THEORETICAL COST OF MANUFACTURE BY ELECTROLYSIS.

Theoretically, the cost price of the manufacture of aluminum by direct electrolysis has already been brought down very low as compared with the cost of the more complicated processes of a few years ago. The cost per pound is about as follows:

2 lbs. of alumina (Al_2O_3, contains 52.94% Al_2) at 3 cts.	$.06
1 lb. of carbon electrode at 2 cts.	.02
Chemicals, carbon dust and pots	.01
22 E. HP. exerted one hour, water power being used	.05
Labor and superintendence	.03
General expense, interest and repairs	.03
Total	$.20

I would say here that while the actual cost of the metal produced by the Pittsburg Reduction Co., or any other of the concerns mentioned as actually putting aluminum in limited quantities on the markets to-day, are nothing like these figures as a total, at the same time, as the most economical methods are used, figures approaching these will undoubtedly be attained; and, moreover, improvements in new processes will in many cases probably be equally applicable in reducing costs by the present electrolytic methods. As stated before in this paper, no process can be devised that will give less loss of ore than that of the Hall process, where it is practically nil, nor is it probable that any other method can be devised that is able to give purer metal than that made by the Hall process. Analyzing the items of cost given above, the ore will probably be the greatest item of expense in any successful process, and surely the oxide, alumina, is not only the richest and most easily prepared pure ore, but will prove one of the cheapest, if not the cheapest, of compounds from which to extract the metal. Quite surely no difference here in the art will make an insurmountable barrier of cost for the electrolytic processes now in use to compete against. The expenditure for other reagents than the ore, for carbon, and for chemicals, is now less than 5 cts. per lb., with the Pittsburgh Reduction Co., and in the estimate can fairly be reduced to 3 cts. per lb. for a large plant, with most favorable arrangements made for its supplies. In the item of electrical power there certainly may be room for a large curtailment of cost; but, even should this expenditure of electrical power be lessened one-half, or entirely done away with, heat alone being substituted as the energy for reduction of the ore, it will be difficult to conceive of a method that would not require a cost of at least one cent for this heat, which would be a saving perhaps of 4 cts. per lb. upon this item of electrical power. However, I feel confident that should such processes be devised, the increased expenditure for chemicals and other reagents besides the amount quoted as necessary for the Hall electrolytic process will nearly if not quite counterbalance the saving in electrical energy expended in the Hall process.

In the items of labor, superintendence and general expense, interest and repairs, there may be material saving made by a process yielding metal more rapidly than by the comparatively slow electrolytic process. But the plant required by the Hall process is very simple—especially if located upon water power—and the repairs are very small in proportion to the output. It will be doubtful, therefore, if a saving of more than 3 cts. per lb. can be made, or one-half of the total estimated as necessary for the manufacture of aluminum by the Hall process. Thus the total saving probable, or, I think, I am almost justified in saying, even in these days of wonderful inventions, possible, is only about 7 cts. per lb. over the cost of the Hall process. A greater saving than this may per-

haps be made if some bright artist shall be able with Aliadin's lamp to rub the clay bank with his magic wand and extract "the silver from the clay" by his incantations; or, perhaps, more soberly, some one may find a method of reducing aluminum from some of its compounds as a by-product, the expense of which shall entirely or mainly be borne by the other valuable products made.

POSSIBLE COMPETITORS OF THE ELECTROLYTIC PROCESS.

In this connection, an ingenious method has been devised to electrolyze the sulphide of aluminum or the double sulphide of aluminum and sodium in a tank, closed and suitably insulated and connected with a powerful electric current. The tank is filled with charcoal, covered with alumina, or, in case the double sulphide is to be made, with a mixture of alumina and some sodium salt. The tank is heated to incandescence by the electric current, and fumes of sulphur are forced into the tank. An atmosphere of bi-sulphide of carbon is produced; the excess is carried away by a condensing pipe, and is calculated to yield revenue enough to pay for the entire operation, which consists further in reducing the sulphide of aluminum produced by a portion of the bi-sulphide of carbon acting upon the alumina in the presence of the heated carbon. The sulphide of aluminum is electrolyzed in the lower part of the tank, the molten metal going to the bottom, where it is afterward tapped out. The evolved sulphur again attacks the hot coal and produces bi-sulphide of carbon. This process looks very pretty on paper, but, unfortunately, it has not thus far proved financially successful.

The only method which seems at all likely to supersede the electrolysis of alumina as the most economical method of manufacture of aluminum is some variation in the condition of reduction (such as performing under pressure or the like). The oxide, or an equivalent aluminum compound, would have to be cheaply prepared, by the aid of carbon at a much lower temperature than s now possible by the means already tried. If such a feat could be accomplished, the changed conditions under which the carbon was to work not being too expensive to attain, and the reduction being accomplished rapidly enough to admit of the process being used upon a large commercial scale, then the electrolytic methods of manufacturing aluminum would have to be relegated to the same fate that has already overtaken the sodium method of reduction. But in the light of what I have already said, I venture here to predict a long life and a happy one yet for the electrolytic methods of manufacture of aluminum.

In closing, I wish to acknowledge my indebtedness to Prof. Jos. W. RICHARDS, of Lehigh University, not only for personal statements and suggestions which I have embodied in this lecture, but also for data from his admirable book on aluminum. It is the first work on the subject printed in the English language, and I prophesy that it will always hold an authoritative position among the best treatises on the metallurgy and properties of aluminum, a place akin to that held by PERCY'S "Metallurgy of Steel and Iron."

Re-enforcement of Foundations.

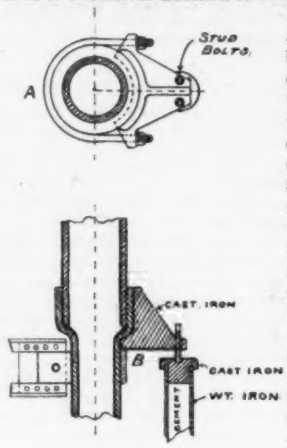
The following account may be of interest to engineers as a quick piece of work, and instructive to architects as a means of re-enforcing or underpinning the walls and piers of buildings. It will be seen that, for this latter case, the method has many applications, and that, with some calculation and careful regard to the direct and cross strains and construction of details of the connections, it is very practical and economical for many cases where stories are to be added to the building, where local settlements need to be checked, where alterations have concentrated extra weight upon certain piers, and where there is no authentic record of the old footings and foundation soil. Many an architect will recall cases such as this last one, where any method would have been welcome that would have avoided the long, expensive and cumbersome system of shoring and underpinning.

Three years ago the firm of Constable Bros., Architects and Engineers, of New York, was called in to discover and correct the sticking and warping of the ends of an iron draw span. Several attempts had been made to correct the trouble, but with only temporary success. The track had been lined up over every pile with wedges and plates from time to time, but the span was again out of true. A level was strapped to the middle pile of the draw pier, and the level of the track taken. The profile of the track shows the irregularities discovered.

Careful investigation showed that there had been a considerable increase in the scouring action of the river at this point, arising from the reduction of the cross section of the river by the piles of the bridge, and the addition of fenders, and bunches of guard piles above and below the bridge. The river-bed was sand, underlaid by a bed of ferruginous gravel at varying depths, and the piles had been sunk by both hammer and hydraulic jet, and in some cases without shoes (where hard ground had been encountered); therefore, the foundation was not uniform, and the loss of skin friction by scour around some of the piles, together with the effect of vibration on those driven without shoes, was sufficient to cause continuous and irregular settlement.

The bridge was a double track highway bridge, and subject to a great amount of travel, and also to great demands upon the draw from passing vessels. The bridge overhung the circular piles in the draw pier, and the draw pier was surrounded and made rather inaccessible by a heavy fender and bracing. It was decided to be impracticable to stop traffic or the opening of the draw for more than a few minutes at a time, or for more than an hour during the night; also, that any new work must be of iron; therefore, without great expense, it was impossible to substitute new piles with greater bearing surface or deeper penetration.

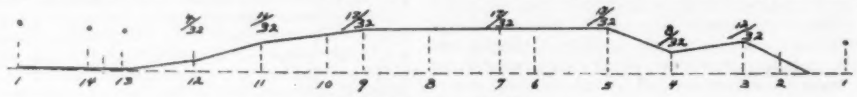
The method adopted was to drive a new pile outside of each old one, then to fit a bracket on to each old pile, and transfer some of the weight to the new ones by means of set screws, and then level up the drum and track. The brackets were made as shown, and secured to a shoulder on the old piles, as



Lateral Struts.

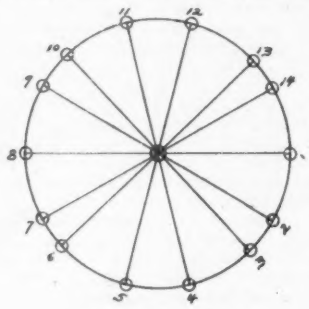
The shears were put up one afternoon, and the men of the driver notified to be on hand at 7 P. M. Men were stationed at the ends of the bridge to give notice of any approaching train, and the draw was swung around over each pile, or closed, on signal. At 8 o'clock the next morning the 14 piles were driven, much to the surprise of the contractor, who rather expected two weeks of extra work. When the track was leveled the bridge came back to its proper bearings, and has worked well ever since.

Some little trouble had been experienced from the bridge being harder to open during the heat of the day than at night.



PROFILE OF TRACK.

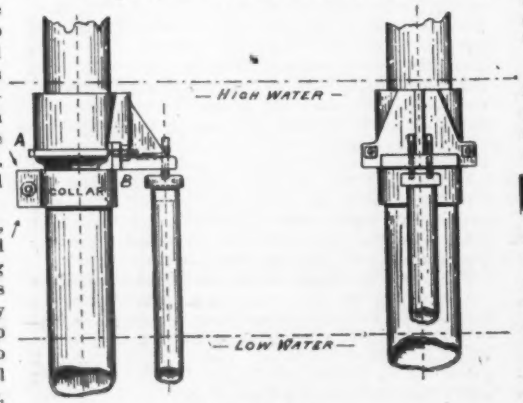
shown at "A," the bracket bearing on the shoulder by means of a lip, cast to fit accurately, as shown at "B." The brackets were made of extra-tough cast-iron—Messrs. J. B. & J. M. Cornell giving special attention to the mixture, the perfection of the castings, and the fitting. The re-enforcing piles were made of double-extra heavy pipe-line pipe, thoroughly tarred and driven to place, and then pumped out and filled with cement, the cap put in place, the bracket swung around over the same, and the straps



Plan of Draw Pier.

tightened, and the set-bolts set to place with 6-ft. wrenches. It was calculated that about 30% of the weight on the old pile was transferred to the new.

The most difficult part of the undertaking was to drive the piles, and no contract could be let for the same. It was finally decided to have special shears made, and to attach them to the railing of the draw span and brace to the trusses, and transfer the 2,000-lb. hammer to them, to locate the driver at the end of the fender, out of the way of the channel, and lead the hammer rope through snatch blocks to the engine drum.



Lateral Braces.

An experiment was tried by painting the upper chord of the bridge white, which resulted quite satisfactorily.

The State Railway Commissions on Rate-Fixing Powers and Railway Safety Appliances.

The annual convention of State Railway Commissions has been in session at Washington this week. Chairman COOLEY in opening the convention defined "the Railway Problem" as follows:

We distinctly indicate the main source of difficulty when we place our finger upon the power as it exists now to make and unmake the rates for passenger and freight transportation. So long as five hundred bodies of men in the country are at liberty to make rate sheets at pleasure, and to unmake or cut and recut them in every direction at their own unlimited discretion, or want of discretion, and with little restraint on the part of the law, except as it imposes a few days' delay in putting changes in force, the problem will remain to trouble us. The mere existence of the power makes losses, disorder and confusion constantly imminent.

The authority to reduce rates, when they are found to be excessive, is but a slight corrective, and reaches the evils only on the public side; I need hardly remind you, who understand it so well, that in this matter of rates, the power on the part of the public authorities to compel the railroads to do what is just to each other in respect to observing rates which they have once made and to adhering to rate sheets until there is reasonable ground for changing them, is so very slight that it may really be regarded as too insignificant to be spoken of as possessing substantial value.

Evils arising from discrimination in the use of freight cars owned by shippers were discussed in a paper by Interstate Commissioner AUGUSTUS SCHOONMAKER. It was recommended that mileage rates on such cars should be no greater than the amount saved to the carrier by the use of the car.

Resolutions were adopted affirming the powers of Congress and of state legislatures to regulate rates for freight and passenger traffic, and to delegate their rate-making powers to Boards of Commissioners, whose decisions on questions of fact should be final and binding. The following resolutions concerning safety appliances were also adopted:

That a committee of five be appointed by the Chair to urge upon Congress, as soon as possible after the opening of its next regular session, the imperative need for action by that body calculated to hasten and insure the equipment of freight cars throughout the country with uniform automatic couplers and with train brakes, and the equipment of locomotives with driving-wheel brakes, and present and urge the passage of a bill therefor.

That the committee, before presenting the bill to the appropriate Congressional committee, be requested, after public notice, to give a hearing to accredited representatives of such organizations of railroad officials or employees as may desire to be heard.

The Brooklyn Water-Works Extension.

[WITH INSET.]

I.

THE EXISTING WORKS.

The first movement to secure a general water supply for Brooklyn was made in 1834, just previous to its incorporation as a city, and when the population was over 20,000. Thirteen years passed by before public action was again taken. The population at this time, 1847, must have been about 75,000. The people clung so tenaciously to their supply from individual wells that it was not until July 31, 1856, 22 years after the first report on water-works, and when the population was at least 215,000, that the construction of works was formally begun. In December, 1858, water was let into the city. On Dec. 16 it was first used to extinguish a fire at the corner of Myrtle Ave. and Schenck St. Since that time the works have been constantly in use, although their completion was not celebrated until April 28, 1859, and the works as a whole were not accepted until May 25, 1862.

The early plans are notable as recommending wells for a source of supply, and as providing for a very limited consumption of water, the allowance in some plans being as low as 30 galls. per capita. All of the plans included a pumping system, and most of them located the distributing reservoir on Mt. Prospect, where the high service reservoir is now located. Among those who recommended wells as a source of supply was Maj. D. B. DOUGLASS, in 1835, and again in 1847.

The first man to recommend a part of the source finally adopted was WILLIAM BURDEN, an engine builder, who in 1849, or a little earlier, proposed that a pumping station and stand-pipe be located at Jamaica creek, the first constant stream east of the city. The pumps at this station were to discharge into a pump-well at Flatbush, from which water would be repumped to a distributing reservoir.

In 1851 an appropriation for preliminary surveys was made, and under the direction of WILLIAM J. MCALPINE, an examination of several streams was carried out. Mr. MCALPINE presented a preliminary report Dec. 20, 1851, which was concurred in by JOHN B. JERVIS. April 15, 1852, Mr. MCALPINE submitted a final report, with plans and estimates. This report showed the undesirability of a supply from wells, lakes on Long Island, or the Croton and Bronx Rivers, across the East River in Westchester Co. It submitted five plans, providing for from 5,000,000 to 30,000,000 galls. per day at a cost of from $3,750,000 to $7,840,000. It included a pumping station at Bedford Creek, in Flatbush, force mains to a distributing reservoir on Mt. Prospect, 190 ft. above mean high tide, and 121½ miles of distributing mains. The report presented gagings and examinations of streams on the southern slope of Long Island, as far east as East Meadow Creek, one of the supplies now being made available, 21.3 miles from the proposed pumping station. The plan provided for ponds on the various streams, formed by dams, raising the level from 1 to 9¼ ft. An open conduit was to carry the water from the ponds to the pumps.

July 11, 1853, a proposition to build works in accordance with the above plan, at a cost of about $4,000,000 at the start, was defeated by a popular vote of 5,054 to 2,639, less than one-half of the electors voting. Later, another proposition was voted down in a similar way.

The further history of the attempt to secure a water supply is largely the history of a company incorporated April 16, 1852, as the Williamsburgh Water-Works Co., with a capital stock of $500,000, for the purpose of supplying Williamsburgh. Successive acts enlarged the company's powers and capital stock so that it might supply Brooklyn, and changed its name to the Long Island Water-Works Co., the Brooklyn Water-Works Co., and, finally, April 12, 1855, to the Nassau Water-Works Co. The city was authorized to subscribe for $1,000,000 of the Long Island Water-Works Co.'s stock, and later, for $1,300,000 of the stock of the Nassau Water-Works Co. Finally the latter subscription was made. The company had already contracted with Henry S. Wells & Co. for the construction of the works for $4,200,000. In 1857 all the stock of the company was transferred to the city, which for some time had practically been controlling the company's operations.

The engineers employed by the various companies were Gen. W. B. BURNETT and SAMUEL MCELROY, Chief Engineer of the Nassau Water-Works Co., under which construction began. In June, 1856, Mr. MCELROY resigned, owing to a change in the directors of the company, and shortly afterwards JAMES P. KIRKWOOD was appointed in his place, and retained the office until after the completion of the works, Mr. MCELROY, MOSES LANE and J. O. WEBSTER being assistants.

The surveys under Gen. BURNETT, and under the immediate charge of DANIEL MARSH, were extended in 1852 as far east as Maasapequa Pond, the last pond drawn from by the present extension.

The conduit as originally completed extended east from the pump-well at the Ridgewood pumping station 12.39 miles to Hempstead Pond and drew a supply from six ponds. With the exception of Hempstead, all the ponds are connected with the conduit by branches. The combined daily capacity of the six ponds for delivery at their lowest stages is given by Mr. KIRKWOOD, in his report on construction, as 19,603,539 galls.

The conduit had a daily delivery capacity, with water 5 ft. deep, of 47,000,000 galls. at the lower end and 28,500,000 galls. at the upper end. The two pumps at Ridgewood had a daily capacity of 10,000,000 galls. each. There were two 36-in. force mains, each 3,450 ft. long, rising 152 ft. to the Ridgewood Reservoir. The Ridgewood Reservoir had a capacity of 160,000,000 galls. The other features of the original works were the Mt. Prospect high service pumping station and reservoir, located within the city, and drawing their supply through a 30-in. branch main 4,600 ft. long, which tapped a 36-in. supply main at a point 26,062 ft. from the Ridgewood Reservoir. The high service pumping engine had a daily contract capacity of about 3,250,000 galls. and the reservoir a storage capacity of 20,000,000 galls. A 20-in. force main, 2,052 ft. long, connected the pumps and reservoir.

As originally designed the conduit was to have been closed only from the pump well east to Jamaica Pond, a distance of 5.4 miles. The remaining distance it was to be an open canal, connected with the various supply ponds by branch canals. By this means the supply from all the streams crossed by the conduit would have been intercepted, and nearly the whole of the available supply would have been secured. After construction began Chief Engineer KIRKWOOD recommended that the open canal be changed to a brick conduit, on the ground that with winds and storms the canal section could not be maintained through the sand f Long Island. It was not until the works had been put in operation, the brick conduit to Jamaica Pond having been completed, that Mr. KIRKWOOD was authorized to extend the brick conduit the remaining distance.

In a paper read before the Constitution Club of Brooklyn, March 8, 1885, SAMUEL MCELROY, Chief Engineer before Mr. KIRKWOOD'S appointment, states that by changing from an open to a closed conduit "about 12 streams and numerous land springs on the line of works were lost to city interception." He also states that 60% of the annual discharge of water from above the conduit line passed beneath it and was wasted prior to the establishment of pumping stations below the conduit.

However this may be, the original supply from the six ponds has been increased from time to time by the addition of seven pumping stations, located as shown by the general map on the accompanying inset, so the supply is now estimated to be about 50,000,000 galls. Three of these stations, known as Springfield, Watts' and Smith's, draw from open wells 50 ft. in diameter and 15 ft. deep, connected with ponds of the same name, the Springfield station being connected with a fourth pond—Cornell's. All the ponds have been added since the original works were built. The remaining stations derive a supply from gangs of driven wells, which Chief Engineer VAN BUREN'S report for 1886 credits with a daily supply of 20,000,000 galls. Previous to the addition of the pumping stations a large storage reservoir was constructed, the Hempstead, built in 1873-6, with a capacity of 1,000,000,000 galls.

THE WATER-WORKS EXTENSION.

The storage reservoir built in 1873-6 was designed to furnish a summer supply of 30,000,000 galls. daily, but in a succeeding dry season it was empty when most needed.

ROBERT VAN BUREN was appointed Chief Engineer of the Department of City Works in 1877. Recognizing the need for an increased supply, he at once requested an appropriation for the purpose of gaging streams east of the Hempstead storage reservoir. This appropriation was not granted until 1881, after the failure in 1880 of the storage reservoir supply. The various pumping stations were put in under Mr. VAN BUREN'S direction for temporary relief, but proved a most valuable acquisition, nearly doubling the supply.

In 1885 surveys and plans for an extension of the aqueduct east of Rockville Center were completed and reported upon. The work was done under the direction of Chief Engineer VAN BUREN, with I. M. DE VARONA Assistant Engineer in charge.

In 1888 JOHN P. ADAMS became Commssioner of City Works. Bonds for a new pumping station at Ridgewood, a 20,000,000-gall. pumping engine, and an enlargement of the Ridgewood reservoir were authorized during the summer. The combined efforts of Commissioner ADAMS and Chief Engineer VAN BUREN, together with a special message from Mayor ALFRED C. CHAPIN, in July, 1889, finally prevailed, and the construction of the water-works extension was authorized and contracts let before the winter of 1889 set in. The works is now well under way, and some parts of it ready and others quite completed.

The extension will be best understood by referring to the general map and the profiles on the accompanying inset, where the present water shed and the addition now being made to it are shown, as well as the various supply ponds, old and new, the old and new conduits, the Ridgewood and Mt. Prospect reservoirs and pumping stations, the general plan of the city, a profile of Long Island, and of the old and new conduit lines. The extension adds to the existing sources fire supply ponds with a combined storage capacity of 1,140,000,000, and a storage reservoir with a capacity of 413,700,000 galls. From the most easterly pond, Massapequa, the conduit is of brick for 37,437 ft., or over 7 miles, to a pumping station at Millburn. From this station a 48-in. force main, 7,938 ft. long, delivers water into the Baldwin storage reservoir. From this reservoir a 36-in. main, 7,648 ft. long, forms a connection with the old conduit, and a 48-in. main extends to the connecting gate-house and alongside the old conduit to the Ridgewood pumping station.

The illustrations on the accompanying inset show, aside from the general map, sections of the new brick conduit and a manhole giving access to it; a hub and spigot joint for the 48-in. mains, and details of two of the culverts, types of those used for carrying streams over and under the brick conduit.

Before entering upon a detailed description of the extension, it should be stated that the immediate supply expected from the additional sources is about 25,000,000 galls.

The brick conduit is divided into four sections, the length, dimensions and other characteristics of which are shown by the accompanying tables and the cross-sections on the inset. It will be seen that throughout its length the conduit is placed on a platform composed of 2-in. plank on 3-in. timbers. The material used is spruce. The side walls of the conduit rest on the platform and the invert is laid in concrete. Section No. 1, Millburn to East Meadow, has three different cross-sections, the first being shown on the inset and the third being indicated by the dotted line, the upper 90° of the ring, or the crown of the arch, being 8 instead of 12 ins. thick. In the third case the haunches of the arch are 16 and the crown 12 ins. thick. The approximate quantities per lineal foot are the same in each case, with the exception of the brickwork, which is 40.06 cu. ft. per lineal foot for the cross-section shown, 37.291 for case two and 43.084 for case three.

Each of the sections 2, 3 and 4 has a second case, in which the cross-sections show an arch with an 8-in. stead of a 12-in. crown. In section 2 the quantity of brickwork per lineal foot is 35.312 cu. ft. in case two; in section 3 it is 31.25 cu. ft. in case two; in section 4, it is 29.861 cu. ft. in case two.

Table 1 presents, in a form convenient for comparison, the dimensions given on the cross-sections, and in addition the location and length in feet of each of the four sections, the fall per mile, maximum, minimum, and average depth of cutting, the amount of excavation per lineal foot, and the variation in depth of foundations below the spring line of

TABLE I.—LOCATION, GRADE AND DIMENSIONS OF THE SEVERAL CONDUIT SECTIONS, BROOKLYN WATER-WORKS EXTENSION.

Sections.	LOCATION.	Length in ft.	Fall per mile, ins.	Max. depth of cutting, ft.	Min. depth of cutting, ft.	Av. depth of cutting, ft.	Cu. yds. excavation, per lin. ft.	Depth of foundation below spring line, ft.	Vers. sin. of invert, ft.	Rad. of invert, ft.	Chord of invert, ft.	Radius of upper arch, ft.	Height of side walls, ft.	Clear inside height, ft.	Total area of section, sq. ft.	Diam. of equivalent circle, ft.
1	Millburn to East Meadow	8,904	0.528	23.9	5.1	17.7	9 86	5.5 to 11.0	1	11.39	9.33	4.667	1 25	6.917	52.134	1.146
2	East Meadow to New Bridge	6,375	0.528	17.0	3.3	11 9	6.43	4.5 to 10.8	1	9.18	8.33	4.167	1.25	4.417	43.237	7.400
3	New Bridge to Ridgewood	8,168	0.528	17.7	5.7	12 1	6.04	5.4 to 8.8	1	8.50	8.00	4.000	1.25	6.250	40 537	7.200
4	Ridgewood to Massapequa	13,900	0.528	21.4	5.7	15.0	6.91	5.5 to 10.2	1	7.22	7.33	3.667	1.25	5.917	35.223	6.700

TABLE 2.—LINE OF MAXIMUM FLOW IN CONDUIT, THE RESULTING CAPACITY AND VELOCITY AT EACH SECTION ELEVATION OF THE FLOW-LINE, ETC., BROOKLYN WATER-WORKS EXTENSION.

Sections.	Names of streams flowing into each section.	Clear inside height, ft.	Depth of water in conduit, ft.	Grade and hydraulic slope, in.	Area of flow, sq. ft.	Wetted perimeter, ft.	Hydraulic mean radius.	Velocity (ft.) per second.	Capacity.		Elevation of flow line at inlet.	Clear height in conduit above flow line.
									Cu. ft. per second.	U. S. gallons in 24 hours.		
1	East Meadow	6 917	5.25	0.528	43 8590	18 6337	2.3537	2.0809	91.2662	58,986,897	7.705	1.667
2	Newbridge	6.417	5.25	0.528	38 .5955	17 8481	2.1625	1.9946	76 9846	49,756,456	8.496	1 167
3	Ridgewood	6 250	5.25	0.528	36.9106	17.6137	2.0956	1.9935	72.1740	46,841.178	9.696	1.000
4	Massapequa	5.917	5.25	0.528	33.3093	17.2158	1.9348	1.8867	62.8447	40.617,508	11.244	0.667

the arch. Table 2 shows for each of the four sections the clear inside height of the conduit, the assumed depth of water, the grade, hydraulic slope, area of flow, wetted perimeter, hydraulic mean radius, velocity of flow, capacity of conduit, elevation of the flow line at each inlet, and the clear height between it and the top of the conduit. It should be remembered that, with the exception of the actual dimensions in accordance with which the conduit is being built, the figures are preliminary estimates.

From the tables it will be seen that the clear inside height of the conduit at its upper end, at Massapequa Pond, is 5.917 ft., or 5 ft. 11 ins., and at the lower end, at Millburn, 1 ft. greater. The greatest width of the conduit, or the chord of the invert, at its upper end is 7.33 ft., or 7 ft. 4 ins., and at its lower end 2 ft. greater. The theoretical daily discharge capacity of the conduit at the upper end is 40,617,508 galls., and at the lower end, 58,986,807 galls.

Access to the brick conduit is secured by manholes placed at suitable intervals. The details of their construction are shown on the inset by two sections, one a cross-section through the conduit, and another a longitudinal section.

The general type of the hub and spigot joints for cast-iron mains is also shown for a 48-in. pipe on the section. The pipe is in 12-ft. lengths. The weight of a length of 48-in. pipe, of the section shown, is 6,373 lbs.

To provide for the flow of streams intersected by the conduit extension, 16 culverts and open canals were constructed. Seven of these were on the pipe lines, and in each case were carried beneath the mains. Of the above number, 5 were 12 ins. in diameter, two being arch culverts and three cast-iron pipes. Of the remaining two culverts, one was a box culvert, 2 × 2½ ft., and the other a syphon culvert, 12 × 4½ ft.

On the old brick conduit it was found that culverts carried beneath the conduit gave trouble by stoppages and to avoid this all but one of the 9 streams crossed by the new brick conduit are carried over instead of under the structure. The culvert carried under the conduit is formed by a 20-in. iron pipe. Of the eight remaining streams, four are carried over the conduit through an open canal; one is carried over through a 12-in. cement pipe, one by a 16-in. cast-iron pipe, and two by 20-in. cast-iron pipes.

As most interesting and as types of the others Culverts No. 8 and 13 are shown on the inset. Culvert No. 8 consists of two 20-in. pipes passing through the top of the brick conduit, above the flow line. In this connection a gatehouse and overflow are presented at the right of the culvert, which is shown by the plan and by the section *K-L*. Before passing into the culverts the water of the stream enters a receiving basin, shown by the plan and by section *A-B*. This chamber is 6 ft. wide, 6½ ft. long and has side walls 3.6 ft. high above the paving. It is founded on a platform like that for the conduit, and has a paving of stone on concrete. A wall 2¼ ft. high above the platform is built across the outer end of the chamber with its top 2.6 ft. below the top of the side walls of the chamber. The 20-in. pipes pass through the top of the conduit at a slight grade, which is increased considerably at the point of clearance. The pipe culverts discharge into a paved basin similar to the one just described. The embankment over the conduit is re-enforced to a point about 2¼ ft. below its top by walls extending for a short distance each side of the culverts and gatehouse.

Culvert No. 13 is an open canal, and its details are very clearly shown by the plan and longitudinal section. The bed of the stream being too low to permit its waters to be carried above the top of the conduit or by pipes through the conduit above the flow-line, therefore the conduit beneath the stream was changed to two 48 in. cast-iron pipes, a gatehouse or receiving chamber was placed at one end of the pipes and a manhole at the other, and the stream was carried above, as shown. Both the manhole and the receiving chamber are paved with stone on a concrete foundation, and the 48-in. pipes are laid in a core of concrete. The bottom of the canal is 8 ft., the top 18.8 ft. wide, and the depth is 2.7 ft. The slopes are 2 to 1, both bottom and slopes being paved with 9-in. split stone paving. On the right the paving is continued from the top of the slope horizontally 2 ft. to the wall of the receiving chamber. On the other side the paving is carried horizontally 1 ft. to, and a little less than 1 ft. into the embankment, which slopes 2 to 1. On the up-stream side the conduit embankment is protected for some distance each side of the culvert by a retaining wall, evidently carried to the full height of the embankment. On the other side the paving is carried 20 ft. down-stream from the center of the conduit.

The treatment of the culverts seems ingenious and is evidently well fitted to avoid stoppage, which gives trouble on the old conduit line.

(To be continued.)

THE RESPONSIBILITY FOR THE FOURTH AVE. TUNNEL DISASTER has been placed by the Coroner's jury on the New York, New Haven & Hartford R. R. Co. and its officers and directors. The jury believe that the block signals were properly set, but that, "owing to the presence of fog, smoke and steam, Engineer FOWLER did not clearly see the signal." Neither did he hear the gong, if it rang. The railroad company is held responsible, first for the engineer's mistake, and second for the fire in the wreck, due to the upsetting of a stove in one of the cars. The jury recommends better ventilation and light in the tunnel, the use of anthracite coal, the employment of an additional operator in each signal cab, uniform speed for all trains passing through the tunnel, and that each train passing through the tunnel be advised of the train immediately preceding it and its reasonable headway."

THE PENNSYLVANIA RAILROAD'S ANNUAL REPORT shows that the downward progress of traffic rates still continues, although the Pennsylvania is in a better position to maintain its rates than almost any other road. The following is the showing for two years past on all lines east of Pittsburg and Erie, a system over 2,400 miles in extent:

	Average cost of transportation.		Average receipts.	
	1890.	1889.	1890.	1889.
Freight, per ton per mile, cts.	9.463	4.273	0.655	0.686
Passengers, per mile, cts.	1.504	1.527	2.077	2 082

The percentage of operating expenses to earnings increased from 66.81% in 1889 to 67.94% in 1890, which taken with the above seems to show that the public is receiving its share of the benefits derived from operating economies.

The company expended during the past year nearly five million dollars in improving the main line between Jersey City and Pittsburg and its equipment. A good share of this was spent on the Jersey City terminals. Over five million dollars was spent in building extensions to the lines east of Pittsburg. The most important of these is the Trenton cut-off, which will obviate hauling through-freight trains through Philadelphia.

THE BROOKLYN & NEW YORK BRIDGE CO. is asking for incorporation at Albany. According to the bill the bridge is to commence at Keap St. and Marcy Ave., in Brooklyn, and land in New York near Chrystie St. The clear height is not to be less than 135 ft. above high water at the middle of the river. The company is to have authority to operate a passenger railway over the bridge. The capital is placed at $10,000,000, and the incorporators named are the Mayors and Controllers of New York and Brooklyn, J. J. O'DONOHUE, GEORGE LAW, JOHN ENGLIS, S. L. HUSTED and others. Mr. O'DONOHUE is President of the Union Ferry Co., and is opposed to the Union Elevated Railway Co.'s proposed bridge at about the same site.

THE FINANCIAL SIDE OF THE CITY & SOUTH LONDON TUNNEL is thus laid down by a correspondent of the New York *Times*: The 3¼ mile tunnel, including all special machinery, extra work at stations, tracks, lifts, engines, rolling stock and complete outfit, cost about $3,750,000. As compared with the older roads per mile of track, we have: District Railway, $4.593,750; Metropolitan Railway, $3,660,000; City & South London, $1,150,000.

THE CHIMBOTE, HUARAZ & REQUAY RY., of Peru, which was partly constructed some 20 years ago, is to be resurveyed. The construction of this road was begun in 1871 by the Peruvian Government and some 60 miles were completed. About one-half of the line was destroyed some years ago by the floods. The road was projected to run from Chimbote along the valley of the Santa River, to Requay, a distance of about 172 miles. Of this distance about five miles were through a narrow gorge entailing very difficult construction and location. It is now proposed to resurvey this portion of the line and also to survey a line over the Cordillera Negra, through which the gorge is cut, with the intention of carrying the line over the mountains by the Abt system of rack railway. The road penetrates a very rich mineral region. A description of the first section of this line was given in the Transactions of the Am. Soc. C. E., Vol. IX.

A LARGE CAPTIVE BALLOON, it is said, capable of lifting 10 persons, will be sent to the coming Frankfurt Electrical Exposition by Capt. RODECK, in order to show the application of electricity to aerial navigation. The screws for lifting and maintaining the balloon at the proper elevation will be driven by electricity, and a telephone connection will be maintained between the car and the ground. Experiments will be made in electrical propulsion and the generation of hydrogen by electrolysis. The apparatus for the purpose will be furnished by Siemens & Halske.

THE NEW YORK & NEW JERSEY BRIDGE CO., that of Judge GEORGE W. GREENE, has been denied consent to bridge the Hudson by the Senate Committee, says Washington dispatches. The New York *Times* now says that the attention of the promoters is to be turned toward the development of rapid transit in New York, under Section 7 of the bridge law, which empowers the company

to build almost any kind of structure it pleases, but unfortunately also expressly forbids it to lay railroad tracks on such structures.

THE LARGEST GANG SAWS FOR MARBLE SAWING ever built are in a mill of the Vermont Marble Co. at Proctor, Vt. Two of the gangs will saw blocks 20 ft. × 10 ft., and four other gangs will saw blocks 18 ft. × 9 ft. The machines were built by the Lincoln Iron Works, of Rutland, Vt.

THE PEOPLE'S RAPID TRANSIT CO. had a hearing last week before the commissioners. Mr. L. E. CHITTENDEN, president of the company, explained its plans as follows: This company proposes to build a four-track viaduct, capable of carrying the longest trains at 40 miles per hour. This viaduct would be located on a purchased right-of-way, extending through the middle of the blocks, and the four or five lower stories would be rented out. The total value of property to be taken, between the Battery and Kingsbridge, has been carefully assessed and found to be about $52,000,000; the construction cost of the viaduct under the roadbeds is estimated at $34,000,000; the cost of road and eqipment would be $18,400,000, or a total of $109,700,000. The probable income has been estimated as follows: Subway rentals, $500,000; underground freight tracks, $1,500,000; net rentals, $3,289,000; passenger traffic (on basis of 165,000,000 and 50% operating expenses), $4,237,000; total, $9,476,000. Mr. CHITTENDEN thought a 4% mortgage for $80,000,000 could be floated without difficulty. He figured out that the block construction was cheaper than a street line for a viaduct of this capacity, as the damage to abutting property in the latter case would practically exceed the value of the real estate in the middle line of the blocks.

A SIMPLE TEST OF WATERPROOF PAINT FOR IRONWORK, recommended to us by the bridge engineer of one of the largest railway systems in the country, is as follows: Take a small piece of iron and paint it thoroughly with the paint to be tested. After drying, place it on a glass plate and wet it with water. Then place a watch crystal or bell glass over it, making the edges tight with gum or varnish. If the paint is pervious to water, the water will gradually disappear, being decomposed by the iron, the oxygen uniting with the iron to form rust. If the paint is absolutely waterproof the water will remain in the chamber indefinitely. It is said that a pure asphaltum paint is the only one which will stand this test.

THE PURCHASE OF THE PROPERTY OF THE LONG ISLAND WATER SUPPLY CO. was declared illegal on Feb. 28 by the General Term of the Supreme Court, sitting at Poughkeepsie. The decision was based on the opinion that the power to buy the works ended with the two-year limit, during which the city had a right to purchase the works under eminent domain, providing a price could not be agreed upon. The two-year limit applied specifically only to the exercise of eminent domain, but Justice BARNARD holds that this limitation implies the further limitation that the works must be purchased within the same period, if at all, by agreement as to price. The above company was supplying water to New Lots at the time that town was annexed to Brooklyn. The annexation act provided for the purchase of the company's works, as stated above, but the purchase was not made until December last. The price agreed upon was the assumption by the city of $500,000 6% bonds and the payment of $300 per share, or a total of $750,000, for the company's stock. In May, 1890, President MCARTIN represented to the tax assessors that the company's stock was worth but $25 per share, and it is stated that a large part of it was recently purchased for $70 per share. A wealthy taxpayer, WILLIAM ZIEGLER, obtained an injunction against the purchase, on the ground of wastefulness and other claims. The injunction was made permanent on the ground of waste and extravagance and finally declared illegal by the Supreme Court, as already set forth.

THE CANDLE POWER OF ARC LIGHTS is a matter of so much uncertainity that the following explanation by Professor THOMSON of the term "2,000 c. p." is very timely: "The term has little significance as indicating the illuminating power of the arc. It is now generally taken to mean an arc with 10 amperes, and not less than 45 volts potential difference between the carbons, or a 450-watt arc. The quality of the carbons will determine whether the 450 watts are expended in obtaining the most light or not."

PERSONALS.

Mr. C. H. PARKS has been appointed Chief Engineer at Waltham, Mass.

Mr. CHARLES SZEN, an engineer on the state canals, died at Buffalo, N. Y., Feb. 26.

Mr. J. HERBERT SHEDD, M. Am. Soc. C. E., has been appointed Assistant City Engineer of Providence, R. I.

Mr. JOHN R. DUFF, railway contractor, died at Boston, Mass., Feb. 27. He constructed the Hannibal & St. Joseph R. R.

Gen. J. V. MESEROLE, a civil engineer of Brooklyn, N. Y., has been elected President of the Williamsburg Savings Bank.

Sir RICHARD MOON, who has been Chairman of the London & Northwestern Ry. Co., England, since 1861, has resigned his position. He became one of the directors of the company in 1851.

Capt. ROBERT W. HUNT, of Chicago, President of the American Society of Mechanical Engineers and Trustee of the Rensselaer Polytechnic Institute, delivered a lecture on "American Rail Mills" before the students of that institution on Feb. 24.

Mr. W. H. GRAVES, C. E., lately delivered an address on the Grand Cañon of the Colorado before the Denver Society of Civil Engineers. Mr. GRAVES conducted the survey of the cañon under Major POWELL, 21 years ago, the first survey made of the cañon.

Mr. R. E. PEARY, Civil Engineer, U. S. N., is making preparations to start upon a new expedition toward the North Pole through interior Greenland about May 1, as described more fully in another column. He expects at least to reach a more northerly point than has ever before been reached by man.

Mr. JOHN LAWLER, Fel. Am. Soc. C. E., died, Feb. 24, at Prairie du Chien, Wis. In 1870 he built a bridge across the river between Prairie du Chien and McGregor, and was afterward President of the McGregor & Sioux City Ry., which is now a part of the Chicago, Milwaukee & St. Paul system.

Mr. JOHN H. HALL, a director of the Manhattan Elevated Ry. Co., of New York, died recently at Thomasville, Ga. About four years ago he became interested in Southern railway interests. He was Vice-President of the Georgia Central R. R. & Banking Co.; a director of the East Tennessee, Virginia & Georgia R. R. and Richmond & Danville R. R., and one of the Vice-Presidents of the Richmond Terminal Co.

Mr. B. C. EPPERSON, Superintendent of the Louisville, Cincinnati & Lexington division of the Louisville & Nashville R. R., has resigned to accept the position of Superintendent of the South Carolina division of the Georgia Central R. R. He will be succeeded by Mr. C. A. DAVIES, Assistant Superintendent of the Birmingham Mineral and North and South Alabama divisions of the Louisville & Nashville R. R.

Mr. WILLIAM F. SHUNK has been selected by the Intercontinental Railway Commission as Organizing Engineer, and will have general charge of the surveys. According to the programme laid down, two parties of engineers will work north and south from a central point in Colombia. In addition to these parties a corps of military engineers is already assigned for duty in the Central American States. The appointment of Mr. SHUNK is a most fortunate one, as his long experience as an engineer and well-earned reputation as an organizer of railway works especially fit him for the duty here assigned to him.

Sir JOSEPH WILLIAM BAZALGETTE, M. Inst. C. E., died in London, Feb. 28. He was born in 1819, and in 1837 became a pupil of Sir JOHN MACNEIL. When he first commenced practice he was connected with a good deal of railway work. In 1848 he was appointed one of the engineers of the Metropolitan Commission of Sewers, and in 1852 was put at the head of the engineering staff. The Commission resigned in consequence of certain failures in several provincial towns, and in 1856 Mr. BAZALGETTE became engineer to the Metropolitan Board of Works of London. In that capacity he devised the plans for the elaborate system of drainage for London which was constructed between 1858 and 1865. He introduced subways for carrying gas and water pipes and telegraph wires under the new metropolitan thoroughfares, to prevent the breaking up of the pavements and obstruction of traffic. Other important public works in London with which he was associated are the Victoria, Albert and Chelsea embankments along the Thames, the bridges across the Thames at Putney, Hammersmith and Battersea, and a number of extensive metropolitan improvements in the way of new streets, subways and artisans' dwellings. He received the order of knighthood in 1874.

SOCIETY PROCEEDINGS.

Rensselaer Society of Engineers.—Regular meeting of Feb. 27; 30 members and 35 guests present. R. A. Cairns, C. E., City Engineer of Waterbury, Conn., delivered a lecture on "Sewerage."

Engineers' Club of Cincinnati.—Regular monthly meeting of Feb. 19, with an attendance of 26 members. Col. Latham Anderson read a very interesting paper on sanitary plumbing under the title of "The Single Trap System of House Drainage," which comprised a general discussion and criticism of the modern system of house drainage, and a description of a proposed plan for the use of a single trap between the sewer and the house.

Engineers' Club of Philadelphia.—At the meeting on Feb. 21, President Wilfred Lewis in the chair; 45 members present, the report of the Committee on the Revision of the Constitution and By-Laws was presented by Mr. T. Carpenter Smith, the Secretary of the Committee. On motion the report was adopted and the Committee discharged.

The Secretary then presented for Mr. Percy T. Osborne a large view of the Rivermont Bridge, at Lynchburg, Va., accompanied by a communication describing this structure. Mr. Rudolph Hering presented a paper upon the Action of Sea Water on Steel and Iron. This paper was followed by some discussion, but as Mr. Hering proposed to continue the subject at a future meeting, it was resolved that further discussion be postponed until the completion of the paper by Mr. Hering.

HOWARD MURPHY,
Secretary and Treasurer.

American Society of Civil Engineers.—The regular meeting was held March 4, Vice-President Fteley in the chair and a large number of members present. The Secretary announced the death, on Feb. 24, of Mr. John Lawler, Fellow of the Society. An interesting paper on "A Coffer Dam or Caisson without Timber or Iron in its Construction" was read by Mr. Robert L. Harris, M. Am Soc. C. E., and an abstract of this paper is given in another column. It referred to a novel method for filling the interstices in rip rap, not as in ordinary grouting, but by cement injected in small quantities at a time, so that the spaces would be filled by the gradual accretion of the cement on the stones in successive layers. A vote of thanks was accorded to Mr. Harris for his paper.

The ballot on the proposed new constitution and the separate section thereof providing for affiliation with other societies, resulted as follows, the former being now adopted and the latter rejected:

Adoption of new constitution: For, 269; Against, 35.
Adoption of affiliation section: For, 182; Against, 139.

The following candidates were declared elected:

Members: John A. Bensel, Assistant Engineer, Department of Docks, New York City; W. E. Cutshaw, City Engineer, Richmond, Va.; Geo. L. Dillman, Division Engineer, Union Pacific Ry.; F. L. Hills, Chief Engineer, Wilmington & Northern R. R., Wilmington, Del.; Geo. A. Just, Jackson Architectural Iron Works, New York City; J. L. Lusk, U. S. Engineer Corps, Washington, D. C.

Juniors: O. E. Selby, Louisville, Ky.; J. G. Spielman, Paterson, N. J.

Western Railway Club.—At the meeting on Feb. 17 the subject of vertical plane couplers was discussed by John Hickey (M. L. S. & W.). He believed that vertical plane couplers should be built of the strongest materials available, and should conform to the M. C. B. contour lines. A limit should be placed on the number of different knuckles and locking devices used with the vertical plane coupler to avoid the necessity of a large stock being kept on hand for repairs. Continuing, he said:

It is one of the highest duties of men in charge of railway rolling stock, to use every effort consistent with prudence to do away with the link and pin as a means of coupling freight cars, and substitute the automatic vertical plane type of hook coupler recommended by the Master Car Builder's Association, which is regarded as the best known contrivance for that purpose.

I am firmly of the opinion that until the link and pin couplers are wiped out, the automatic coupler cannot reach anything like the full measure of success, and that there will be more or less trouble with the breakage of knuckles, locking devices, etc. When they are wiped out, however, and nothing is left of them but the bitter remembrance of the widows and orphans they have caused, upwards of nineteen-twentieths of the coupler trouble will cease.

The discussion of Mr. Barr's paper on locomotive counterbalancing was then taken up. Mr. Lewis thought the flat spots described by Mr. Barr were due to variations in the weight on the rails due to lifting action of the counterbalance when at a point half way between its highest and lowest position. Mr. Potter had been troubled by flat spots, but on a different type of engine from that described by Messrs. Barr and Lewis. Mr. Hickey emphasized Mr. Barr's recommendation that reciprocating parts and counterbalance should be made light as possible, and thought this should apply also to all the machinery of a locomotive below the springs.

A paper by Mr. Geo. Gibbs, on "Car Lighting," reprinted elsewhere, was then read. At the meeting on March 17 Mr. John Hickey will present a paper on "Improvements in Locomotive Boiler Construction."

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
EO. H. FROST..... .....BUSINESS MANAGER

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COMING TECHNICAL MEETINGS.

Engineers' Club of Philadelphia.—March 7. Secy., Howard Murphy, 1122 Girard St.

Northwest Railroad Club.—March 7. Secy., H. P. Robinson, St. Paul, Minn.

Engineers' Club of Kansas City.—March 9. Rooms, Baird Building.

Civil Engineers' Club of Cleveland.—March 10. Secy., A. H. Porter, 50 Euclid Ave.

Denver Society of Civil Engineers.—March 10, "Mining Machinery." Secy., Geo. H. Angell.

Association of Provincial Land Surveyors of Ontario.—March 10. Secy., A. J. Van Nostrand, Toronto.

Civil Engineers' Association of Kansas.—March 11. Secy., J. C. Herring, Wichita, Kan.

New England Railroad Club.—Annual meeting, March 11, "Screw Stay Bolts;" election of officers. Secy., F. M. Curtis.

Engineers' and Architects' Club of Louisville.—March 11. Secy., G. W. Shaw.

New England Water-Works Association.—Boston, March 11. "Water Supplies and Public Health." Secy., R. C. P. Coggeshall, New Bedford.

Engineering Association of the South.—March 12. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Northwestern Track and Bridge Association.—March 18. Secy., D. W. Meeker, St. Paul, Minn.

Western Railway Club.—March 17, "Boiler Construction." Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.

Engineers' Society of Western Pennsylvania.—March 17. Secy., S. M. Wickersham, Pittsburg, Pa.

Boston Society of Civil Engineers.—March 18. Secy., S. E. Tinkham.

American Society of Civil Engineers.—March 18. Secy. Francis Collingwood, 127 E. 23d St., New York.

Engineers' Club of St. Louis.—March 18. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.

Engineers' Club of Cincinnati—March 19. Secy., J. F. Wilson.

New York Railroad Club.—March 19. Rooms, Gilsey House. Secy., H. G. Prout.

Southern and Southwestern Railway Club.—Memphis, March 19. "Side Rods, Exhaust Pipes."

Western Society of Engineers.—April 1. Secy., J. W. Weston, 280 La Salle St., Chicago.

Engineers' Club of Minneapolis.—April 2. Rooms, Public Library Bldg. Secy., F. W. Cappelen.

Technical Society of the Pacific Coast.—April 3. Secy., O. von Geldern, 408 California St., San Francisco.

Civil Engineers' Society of St. Paul.—April 6. Secy., G. L. Wilson.

IN our opinion, the true cause of the late collision in the Fourth Avenue tunnel, and of the conflict of evidence in regard to it, has not yet been suggested, if, indeed, it has been thought of; and if our theory of the cause be correct, the occurrence is one demanding careful attention from signal engineers and operating officials charged with the safe operation of tunnels. The key to the mystery, in our judgment, lies simply in the fact that *a white light seen through smoke and fog becomes red*, or rather becomes first yellow, then red, as obscurity increases, while a yellow light becomes red with still less obscurity. This is a well proved and familiar optical law, of which there are numberless examples. The sun itself, seen through the smoke of a forest fire (or through a smoked glass) is blood red. The light of the setting sun is first yellow and then red. Another illustration, familiar to all railway men, at least, is the red light of a kerosene lamp seen through a smoky chimney.

Now, the trainman who daily passes through smoke-charged tunnels sees more or less of this effect at every trip. His mind becomes unconsciously educated to interpret the signals by the formula: Red appearance + dense smoke = white light, from which it is the most natural thing in the world to interpret a red light combined with smoke as probably white. This is the more true as the glimpse which the trainman gets of the signal light in running fast through a smoky tunnel is at best but brief; and he interprets it by a process known as "unconscious cerebration," or "latent thought," of which he is entirely unconscious. The experience of every human being affords many examples of this. For example, the same building in sunlight and in shadow is of a quite different color, as any painting will show; yet whether we see the shaded side or the sunny side, we derive the same impression of its real tint, which is a quite different one from either of the tints actually seen; nor is the mind conscious of incongruity in tint in passing from one to the other. Similarly we interpret form and distance by unconscious mental reasoning based upon experience, which becomes instinctive. The engineman who runs daily through a smoky tunnel has daily to thus reason out the meaning of the reddish tints which are always combined with smoke. Of course 99 times in 100, or 999 times out of 1,000, he does this correctly, or there would be collisions every day; but what wonder is it that at rare intervals, when the obscuring causes are especially potent, he should do this once too often, and interpret a red light 20 ft. off seen through smoke, as a white light 100 ft. off seen through smoke, which would have very much the same appearance?

ON this particular occasion the circumstances were all peculiarly favorable to such mental deception. A long train was being slowly hauled up a heavy grade by an engine which could barely drag it, and which was undoubtedly emitting clouds of smoke and steam, to say nothing of the heavy fog which already filled the tunnel and atmosphere generally. The engine, in fact, was stalled at the top of the grade. Almost immediately thereafter a train *accustomed to find a clear track and white signals ahead of it*, entered the smoke-charged block, running at a high rate of speed. It has been since determined that in a like atmosphere the signals were barely visible 15 ft. off, a distance which a train moving at 30 miles per hour passes in one-third of a second. A white light seen through such an atmosphere from a point where it is barely visible will certainly look "as red as red." Both the engineman and fireman swear positively that they saw this light, and saw it as a white light. We believe they told the truth, in the sense that they saw the same optical effect as if they had seen a white light a little further removed. Having then a room for choice, they naturally followed habit and precedent, and interpreted the red light seen through smoke as the customary white light. On the other hand, the testimony of four different and independent witnesses is even more positive that the signals were actually at red, as is also the testimony of the mechanism, which is of the best known type. We believe they also told the truth, and more than that, told the real truth, while the opposing witnesses told only the apparent truth. It is to be remembered that this is not the first time nor the second nor third nor twentieth time that like "conflicts of veracity" have occurred. They have been especially common in England, whose chronically foggy atmosphere is to be remembered in this connection. That the gong signals did not warn the engineer of his mistake is not at all remarkable, for General Manager PLATT, of the Grand Central Depot Co., has testified that the gong signals cannot be heard except at low speeds.

IF this diagnosis be correct, the remedies which seem to be indicated are these:

1. Use a *white* signal light for safety instead of a *yellow* one, which latter shows an incipient red to begin with, especially if there be any smoke or dirt on the chimney and lens.

2. Use a powerful light instead of a (comparatively) weak one, that the ratio of a given obscuration to the power of the light may be a minimum. Both of these items point to the use of electric arc lights instead of oil lamps for the signal lights.

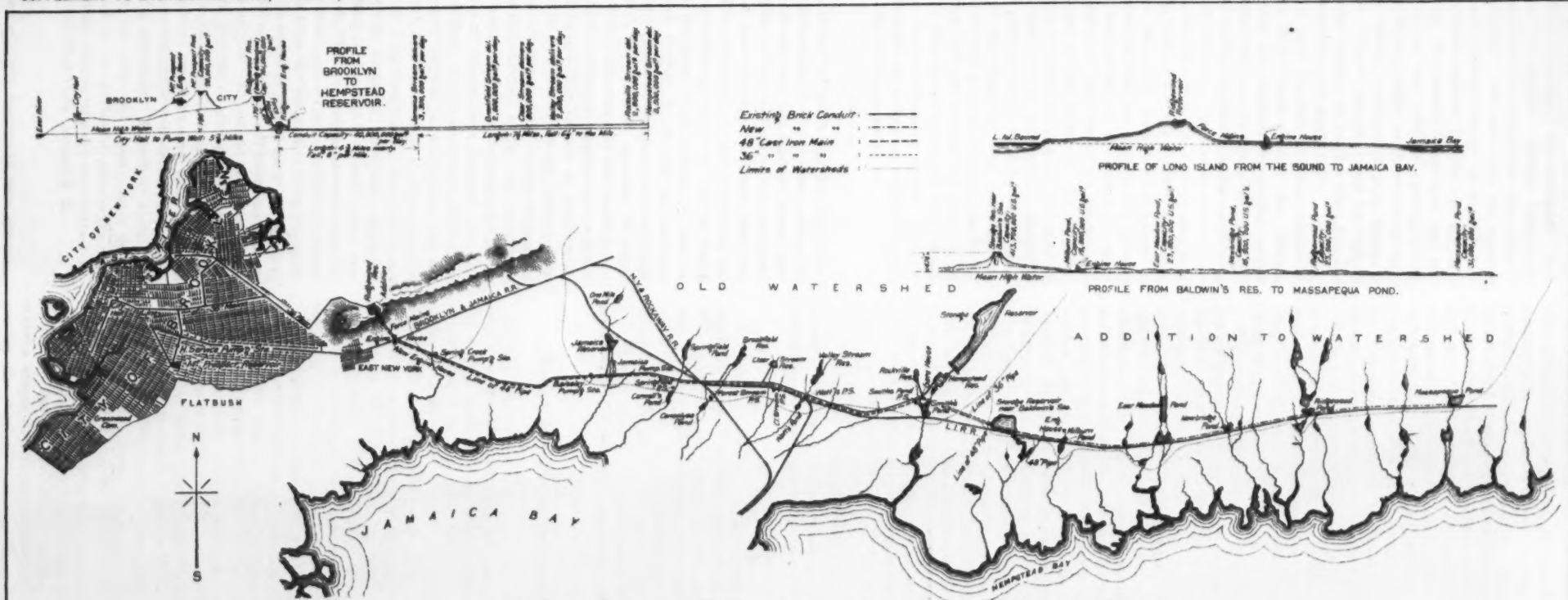
3. Place little reliance on bell or gong signals, which must be intolerably loud to be reliable, and use instead either interlocked automatic torpedo signals or an automatic stop to put on the air brakes, or some appliance to break the cab windows (and thus leave a record of negligence), all of them approved and excellent devices.

4. Do NOT light the tunnel throughout nor any part of it with electric lights, which would compel reliance on the ordinary forms of out-door visual signals, and would certainly be disadvantageous. The darkness of midnight, broken only by the signal lights, is the safest for a tunnel, but these lights should be strong enough to penetrate the most foggy atmosphere to a reasonable distance from the signal.

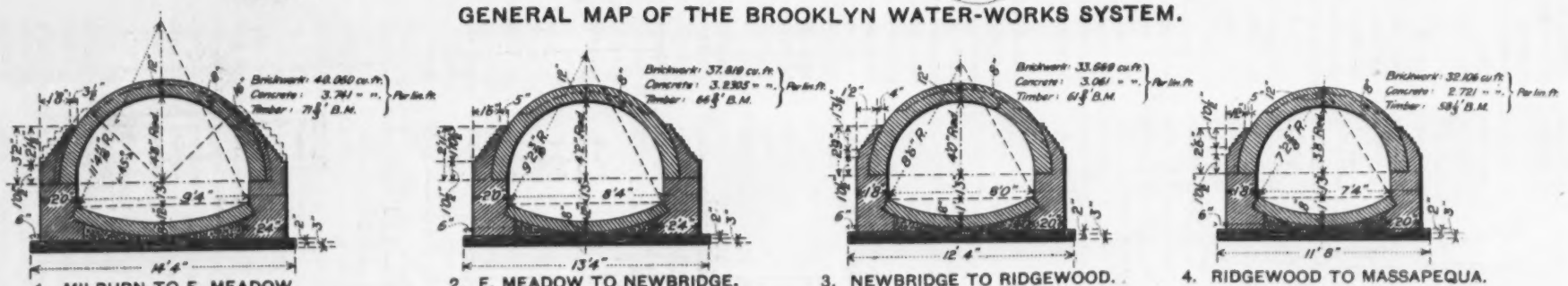
THE investigation has brought out other important facts. The coroner's surgeon testified that at least two of the deaths *were certainly due to the fire*, and not to crushing in the collision. The other testimony seems to show conclusively that the fire was set by the heaters, which, it is to be noticed, were of the Baker pattern, and not ordinary car stoves, which many foolish people seem to fancy are the only really dangerous heaters.

Nevertheless, President CLARK, of the New York, New Haven & Hartford, in his testimony said that it was simply out of regard for the safety of its passengers, and not from mercenary motives, as has been cruelly charged, that his company has steadfastly refused to adopt steam heat. His company is convinced that steam heating is the cheapest system, but it is likewise convinced that the accidental escape of high-pressure steam from a broken heating pipe would "kill every passenger in a car in thirty seconds!" It is to be regretted that Mr. CLARK did not inform the jury about how much high-pressure steam could escape in a minute from a broken two-inch pipe, and did not describe the experiments which his company must have carried on to enable its officers to speak so confidently as to the deadly nature of escaping steam.

IN a recent interview, Mr. CHAUNCEY M. DEPEW is quoted as saying that "a car can be heated more comfortably by the stove than by any other



GENERAL MAP OF THE BROOKLYN WATER-WORKS SYSTEM.



CONDUIT SECTIONS.

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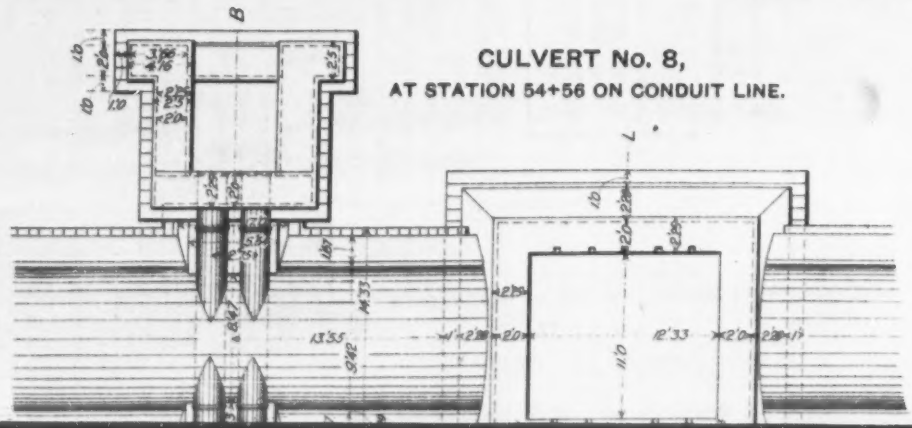
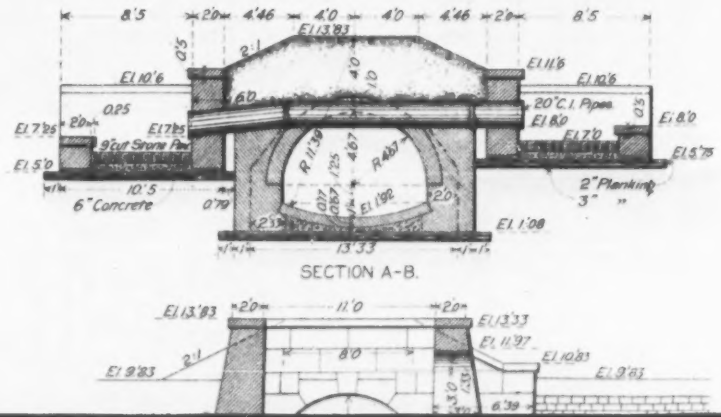
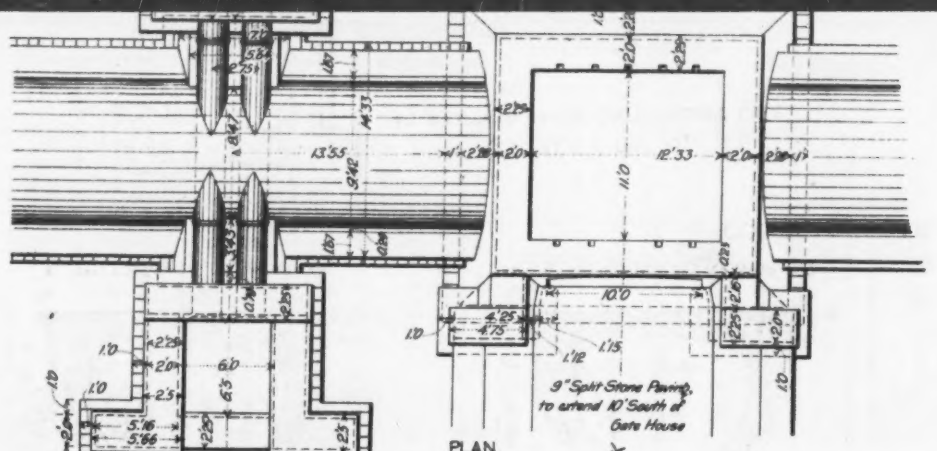
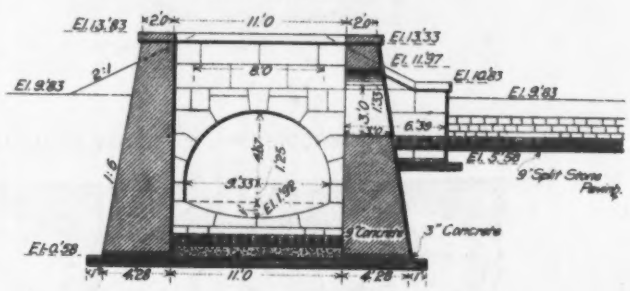
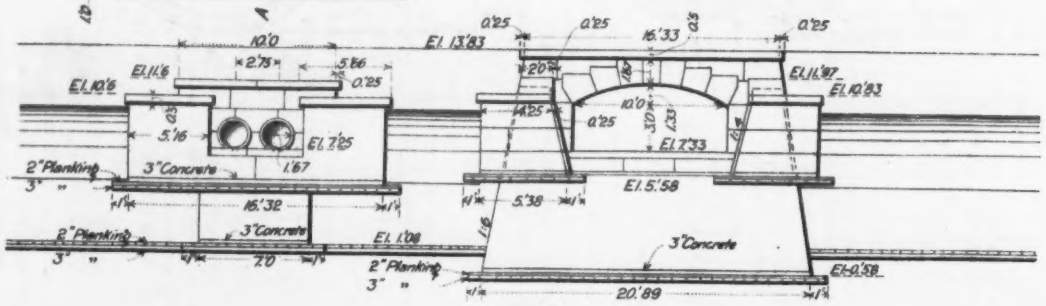
AT STATION 54+56 ON CONDUIT LINE.

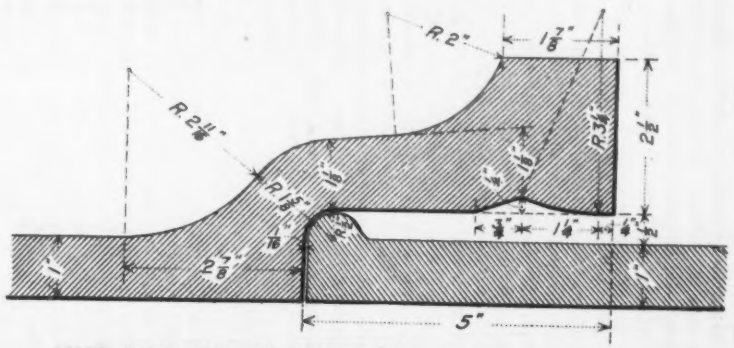


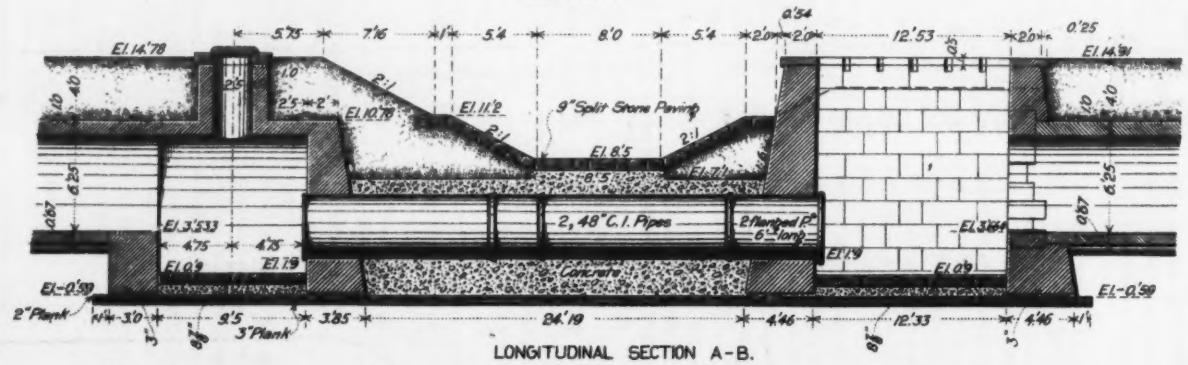


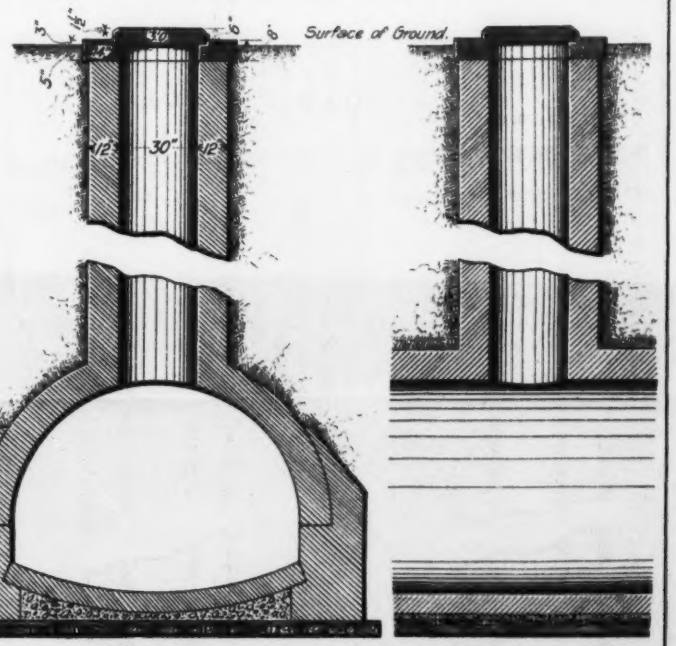




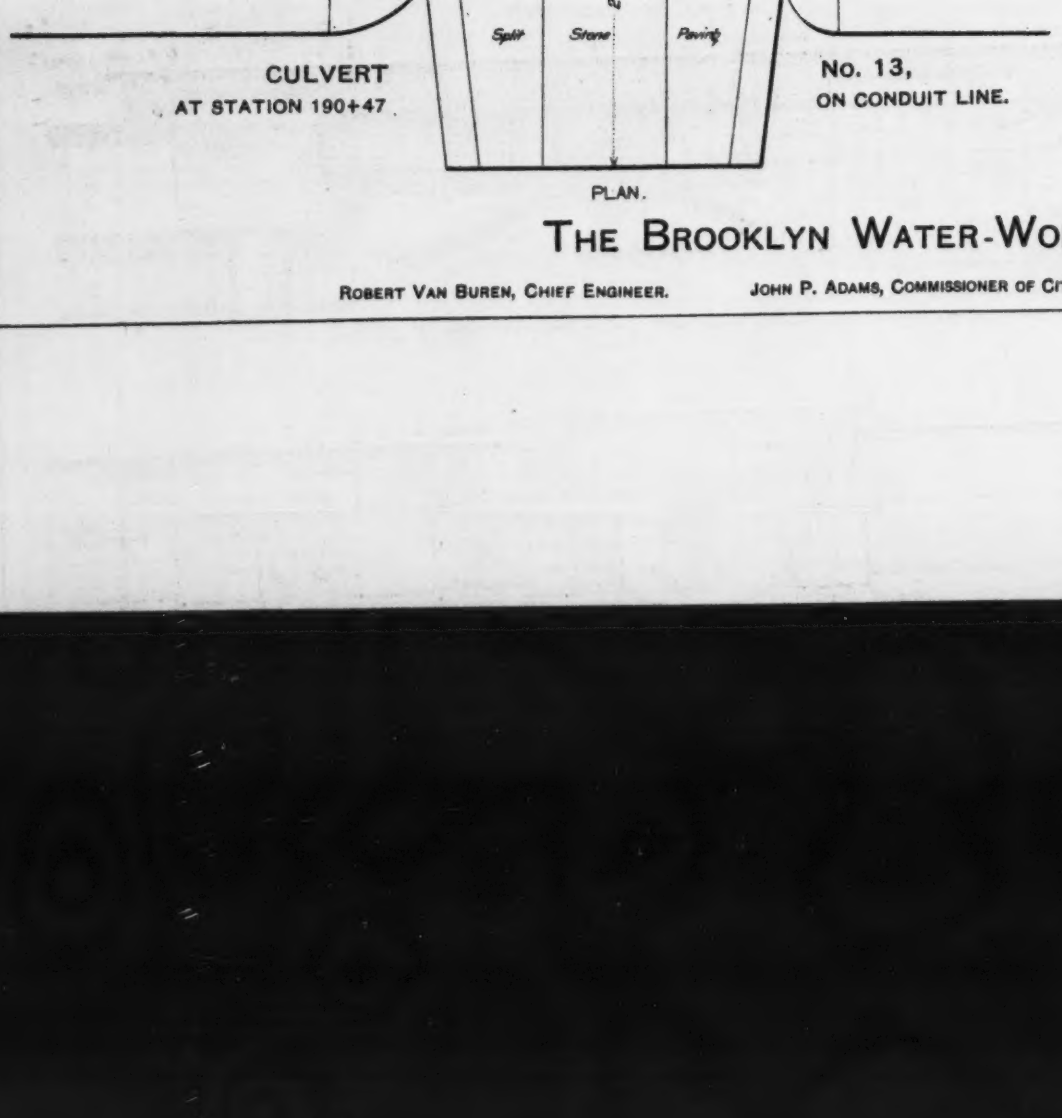








CULVERT No. 13,



CULVERT
AT STATION 190+47.

PLAN.

No. 13,
ON CONDUIT LINE.

CROSS SECTION.

LONGITUDINAL SECTION.

MANHOLE FOR CONDUIT.

THE BROOKLYN WATER-WORKS EXTENSION.

ROBERT VAN BUREN, CHIEF ENGINEER. JOHN P. ADAMS, COMMISSIONER OF CITY WORKS. I. M. DE VARONA, ASSISTANT ENGINEER IN CHARGE.

CHAS. HART & SONS, LITH., 39 VESEY ST., N.Y.

means." "Steam heating," he continued, "has its perils and its dangers, though fortunately passengers have thus far escaped the discomfort (!) of being parboiled." He then told the reporter how he was once sitting alone in his steam-heated private car when he noticed that the car was filling with steam. He hastily threw open the rear door of the car, and the cold air rushing in soon dissipated the steam, which he discovered to have come from a broken "section" of pipe, whatever that may be. "Now suppose," said he, "that I had been asleep instead of awake; why, I should have been suffocated and parboiled."

Certainly if such dangers menace America's most famous after-dinner orator, Mr. DEPEW ought to gratify an appreciative public, which cannot dispense with him, by traveling hereafter with no other heating appliance in his car than an innocuous foot warmer. But in his calmer moments, when the interviewer is not pestering him, we can hardly believe that the incident mentioned troubles him. He surely does not fall asleep in his steam-heated private car, haunted by gloomy fears that he will awake on the following morning so parboiled as to be in excellent condition to attend a dinner of the King of the Cannibal Islands—acting, as usual, as one of the chief attractions, though from a gastronomic instead of an oratorical point of view. Had he really such fears he would make inquiries, and learn that the escape of steam from a broken heating pipe in his car will neither suffocate nor parboil him. If he should be very close to the break, and in the direct current of the steam, and should remain there for some time, he might be somewhat scalded, though in all probability not dangerously so.

As for Mr. DEPEW'S remark that the stove heats a car more comfortably than any other system, he is so clearly wrong that the reporter must have belied him. The evils of overheated cars, irregular distribution of heat through the train, and even the very remote possibility of slight burns and discomfort due to escaping steam are defects which do exist with the direct steam system as used on the New York Central R. R., but do not exist with the return system in use on the Pennsylvania R. R., or with the indirect systems of steam heating now widely used all over the country.

The New York Central managers deserve much credit for their rapid introduction of steam heat, even though the New York law did compel them to move in the reform; and the system adopted by them—whose discomforts, by the way, have been somewhat exaggerated—is immeasurably better than any form of independent heaters. Mr. DEPEW acknowledged, in the interview referred to, that the car stove should be condemned on the score of danger, and he referred to the system in use by the New York Central as "the best in use at the time it was adopted," implying distinctly that he is aware of the fact that still better systems now exist. This is a decided advance upon his position four years ago, when he publicly declared steam heating from the locomotive to be impracticable; but as he would appear to have still much to learn, he should not allow himself to be quoted as an oracle on the subject. He should be content with his fame as the greatest of after-dinner orators, as a bright star in the political firmament, and as an admirable railway president, and should refrain from misleading the public with incorrect opinions on engineering questions. Especially should he avoid exciting his own and others' fears that it may be his lot to be parboiled, save in the mild but exasperating degree usually experienced by passengers on the New York Central R. R.

THE proposed uniform system of tests for iron, steel and other metals, on which a committee of the American Society of Mechanical Engineers is now at work, deserves more general attention from engineers than it has received. The advantages of a uniform system are admitted; but, in order to secure them, the uniformity must be actual as well as nominal. That is to say, the standard must be adopted by practically all the prominent testing laboratories. The committee invites the fullest criticism, and asks that any changes which any engineer wishes to suggest, whether a member of the society or not, should be made now. By this means it is hoped to have the proposed standard code in a shape that will be generally satisfactory to the profession when the committee submits its final report. Any communications may be sent to Prof. F. R. HUTTON, Secretary Am. Soc. M. E., 12 West Thirty-first St., New York City.

While the standard code as now developed by the committee seems on the whole a good one, and for American practice is certainly a great improvement on the German code, it would be well if it were made much fuller and more explicit in many points, especially as concerns the manner of conducting tests. Moreover, the punching test, in the form proposed by the committee, does not seem likely to meet with much favor. The drifting test, described and illustrated in our issues of April 27 and May 18, 1889, might be substituted in its place with much advantage.

Another change proposed by the committee is likely to meet with strong opposition. It is proposed to make no allowance for reduction of area of section in recording ultimate strengths. This seems to be seriously incorrect for the ductile metals which draw down so as to show fifty per cent. or more reduction of area, and it ought not to pass without some protest. We have abstracted the proposed code at some length on another page. Complete copies can be obtained by any one wishing to examine or discuss the proposed code, on application to the secretary, as above noted.

A GENERAL INDEX TO ENGINEERING NEWS, extending from the first issue of Volume I., in 1874, to the end of Volume XXIV. (July–December, 1890), is now in press, and will be issued about April 15, in a separate small volume handsomely bound in cloth, which will be sold at $1. It will prove a valuable work of reference even for those whose files are not complete.

Modern Methods of Car Lighting.

As announced some time ago, this journal has been for some time collecting data on the important subject of car lighting; but unavoidable delays in carrying on the tests have made it necessary to postpone from time to time the presentation of their results. Meanwhile we are in a measure anticipated by a carefully prepared paper on the same subject by Mr. GEO. GIBBS, Mechanical Engineer of the Chicago, Milwaukee & St. Paul Ry., read at the last meeting of the Western Railway Club, the first part of which we publish in this issue.

A considerable portion of Mr. GIBBS' paper is devoted to electric lighting systems; and what he has to say on this topic is of much interest, since the Chicago, Milwaukee & St. Paul is now lighting 62 cars by electricity, which, if we are rightly informed, is more than are so lit on any other steam railway in the world. The system now in use on the road is unique in that it dispenses with storage batteries, and simplifies matters by copying stationary lighting practice, using common types of engines and dynamos in place of the rather expensive special equipment which has generally been used for train lighting. The provision of a separate car to carry the electric lighting and steam heating apparatus is also a unique feature, and a somewhat expensive one by the way, no less than 38 per cent. of the total running expenses aside from attendance being for the extra coal used by the locomotive to haul the car, according to Mr. GIBBS' figures, given below.

Cost of lighting by electricity a 10 car train for an 11-hour run on the Chicago, Milwaukee & St. Paul Ry. Average number of lamps, 87.3.

Items.	Cost.	Per cent of total.
Attendance	$5.25	50
Lamp renewals (3@40 cts.)	1.20	11
Oil and waste	.40	4
Miscellaneous supplies and repairs	.80	8
Coal for light	.87	8
Coal to haul "heat and light tender"	2.00	19
Total cost per trip	$10.52	100
Total cost per car per hour	9.54 cts.	

It will be seen that about half the cost is for attendance, which would not increase sensibly with the amount of light generated; so that for long trains brilliantly lighted, electricity would make a much better showing than it does here.

The use of the separate car is defended on the ground that the locomotive boiler cannot spare steam for both heating and lighting purposes; and it is said that 12% of the boiler capacity is required in not very severe winter weather, when steam for both purposes is taken from the locomotive boiler. But Mr. GIBBS states that the tender car is only used in winter, when steam heat is required, so if the exhaust from the lighting engine is used for heating, which certainly seems feasible, it is hardly apparent why the the tender car is necessary.

The amount of power required to haul the separate car was found to be about 6 per cent. of the locomotive capacity. Rating the locomotive boiler at only 500 HP., about 30 HP. is required to haul the separate car. This amount of steam should certainly be sufficient to warm and light a 10-car train, provided the exhaust steam is used for heating. It is quite apparent that train-lighting by electricity will never become anything but a "luxury," as Mr. GIBBS calls it, if it necessitates the hauling of an extra car in every train lighted. The cost of such cars alone would be a large item in the original equipment, although Mr. GIBBS has made as good a case as possible for the separate car in his estimate by allowing only one to 18 cars lighted.

But on examination of Mr. GIBBS' figures, the prospect that electric lighting may come into general use for railway trains does not seem so remote. The fact that a good part of the electric lighting on the St. Paul road is done with the engine and dynamo in the baggage car proves that the separate car is not essential; and, as seen by the table, the cost of the coal required to haul this car forms nearly one-fifth of the total running expense of the system. The other item of the expense which must be greatly reduced to make electricity practicable for general service is the cost of attendance, which forms 50 per cent. of the total. This may be effected by making the equipment more simple and reliable, and improvements in this direction are being made. Even now, no one would think of paying $5.25 per night for attendance on a stationary plant supplying 80 to 150 lamps, and why it should be necessary on a train, or why we may not expect to see equipments put on the market which can be run by a baggage master with a little special training, is not apparent.

Of the other items, that for oil and waste seems unnecessarily large, and it may be possible to somewhat reduce also the cost of coal for lighting and the cost for lamp renewals. Thus, taking everything into consideration, there seem to be fair prospects that in the near future electric lighting may be lowered to a point where it can compete with other systems for general use on railway trains. This is the more likely, because it is in several points admittedly superior to any other system of lighting. Mr. GIBBS is quite correct, however, in concluding that no system of electric lighting as yet installed on railway trains is satisfactory except for special service.

At the present time there are three systems of car lighting on the market and in extensive use, viz., oil lamps, Pintsch gas and the Frost gasoline

system. Taking up first the question of safety, Mr. GIBBS shows pretty conclusively that the oil lamp need not be banished along with the car stove, provided the car stove continues to depart at its present rapid pace. His argument is based chiefly on the high quality of the oil now in use, and the sensitiveness of the flame to shock. We may add that our own investigations corroborate this opinion. An extensive search through accident records, and repeated public notices requesting the information, have revealed no evidence that the oil lamp for cars has been the cause of fire in a wreck, except in a very few instances of little significance.

The only possible danger which Mr. GIBBS finds in the compressed gas system seems to be the chance of the explosion of a gas tank. But the chances of this are so remote, in view of the vastly greater dangers attendant upon the pursuit of the ordinary routine of existence, that they need not cause much uneasiness.

The chief danger of the Frost or gasoline system Mr. GIBBS believes to be in handling, distributing and storing the gasoline at many points on a large system. He states that not less than 18 per cent. of the contents of a tight wooden package evaporates by standing two months in the oil house. We fully agree with this view, although we are not yet quite prepared to speak more definitely as to the extent and distribution of the danger. Under the circumstances just noted the tendency will be to keep as little gasoline as possible on hand, and it must not infrequently happen that the stock will run low at some important filling point. A new supply will be telegraphed for, and will be very likely to be sent on the first train available. For these and other reasons Mr. GIBBS considers the general use of gasoline at many points on a large system, by necessarily ignorant men, to be "a grave source of danger to life and property, and one which would require modification of the stringent oil inspection laws of many states before becoming legal." This will, in our opinion, be the sober second thought of the entire railway world, in spite of the unqualified indorsements which various railway papers (nearly all of them in fact) have given to the use of gasoline.

Returning to the relative cost of the systems, we abstract the following table from the figures given by Mr. GIBBS:

Cost of different car lighting systems for a 50-ft. passenger car.

System.	No. of burners.	Total candle power.	First cost of equipment. $	Operating expenses per car per hour. cts.	Cost per c. p. hour. cts.
Oil lamps, "Acme" burners...	7	168	113	2.51	.015
Pintsch gas.....	17	170	532	2.60	.015
Frost, gasoline...	5	180	536	4.60	.026
Electric (C. M. & St. P.).....	10	160	395.40	9.83	.061

Mr. GIBBS finds the first cost of equipment to be about $550 per car for both the Pintsch and the Frost systems, which includes the cost of the filling stations and gas works for the Pintsch system. In running expenses, however, the Pintsch system has a great advantage, costing only 2.6 cts. per car per hour against 4.6 cts. with the Frost system. Oil lamps, to furnish an equal amount of light, cost, at the start, only one-third to one-fourth as much as gas or gasoline; but in operating expenses the oil and the gas are nearly equal, oil costing 2.27 to 2.73 cts. per car per hour, while the Pintsch gas system costs 2.60 cts. Practically, therefore, the difference in cost between the oil and the gas systems for equal light amounts to only about $50 per car per year for the depreciation and interest on the larger original investment.

Undoubtedly a car can be furnished with a few smoky, dim oil lamps, and the total expense of the alleged lighting will be much below the figures given by Mr. GIBBS; but while such service is an improvement over the days of whale oil, tallow candles, pine knots, and stage coaches, it is by no means good enough for the present day. The amount of light required for good illumination in a 50-ft. passenger car Mr. GIBBS sets at 150 to 200 candles. Even this he considers too little to give a light by which passengers can read without injury to their eyesight, except by the use of side lamps in addition to those overhead.

On the whole, Mr. GIBBS favors the use of either the Pintsch system or the oil lamps, according to circumstances. In the use of oil, however, he makes the very sensible recommendation that the most improved modern types of burner should be used in place of the old and uneconomical forms. If this is not done the oil lamp cannot compete with gas, either in the illumination furnished or in running expenses. The degree to which Mr. GIBBS' conclusions as to the comparative cost of various systems of lighting correspond with those which we have previously published, and which were at the time widely attacked, we will not now attempt to sum up in detail, as we shall hope shortly to contribute some further original records to those which Mr. GIBBS' valuable paper so ably presents. His paper covers very well a considerable portion of the ground on which we intended to prepare figures, and may relieve us from the necessity of doing so; but on some other points not touched by him we intend shortly to present some data of no small interest, it seems to us, and which tend still further to confirm the conclusions as to the relative merits of the various systems reached by him, as also by this journal some time ago, viz., that either on grounds of safety or economy, the real choice for car lighting purposes lies only between compressed oil gas and high test mineral oils.

Electric Lighting from Central Stations.

At the exhibition of the American Institute, held in New York in the autumn of 1878, Mr. CHAS. F. BRUSH, of Cleveland, O., displayed to the public for the first time a number of arc lamps operated in series, and the next year the California Electric Light Company, of San Francisco, established the first central station for arc lighting. The following year EDISON exhibited his incandescent lamp, and in 1882, only 9 years ago, the first Edison station, with 4,000 lamps capacity, was established in New York. Now, according to the recent address of Mr. PERRY before the National Electric Light Association, the electric light is employed in 6,000 isolated plants, 700 steamboats, 350 gas works, 200 street railways, and 1,500 electric lighting and power stations in the United States alone. The development of electrical industries abroad has not been so rapid as in this country, but even there the spread of electrical lighting and power plants, especially the latter, has been little short of wonderful.

Naturally, the dynamo was the first machine to receive the attention of electrical engineers. Many types have been invented and tried, but in the present practice only a few have any extensive use, the tendency being to thoroughly develop a few more or less distinct forms, just as in steam engineering. To-day the dynamo is as fully developed, and its capabilities and defects as fully understood as the steam engine, while it is a much more perfect machine, from a scientific point of view, in this, that it approaches as closely as any mechanism of the kind can be expected to do to an efficiency of 100, the loss of 10 or 15 per cent. being due to friction or its electrical equivalents only. On the other hand, the steam engine utilizes only 3 to 15 per cent. of the energy which is supplied to it.

It was not until recently, however, that engineers turned their attention to the smaller appliances for electric lighting and power purposes. Yet now it is probably no exaggeration to state that every detail of the electrical apparatus in a central station is as far advanced toward perfection as the power plant which is employed.

But there is still an opportunity for engineers to effect marked improvements. At the last meeting of the National Electric Light Association Mr. SWETLAND read a report of the committee appointed to investigate the economy in the generation of power in central stations. This report is very instructive in more ways than one. In answer to inquiries as to operating expenses, some managers returned the very expressive and comprehensive statement: "Never mind the cost of power, we are paying dividends." Many companies, however, supplied the required data freely, and a tabular statement was presented at the meeting showing the efficiency of a number of plants. An abstract of the best and worse results, from an economical point of view, is given below:

STATISTICS OF CENTRAL ELECTRIC LIGHTING STATIONS.

NAME.	Load.	Average HP.	Hours per day.	Coal per HP. per hour.	Lights. Arc.	Lights. Incan.
Bedford*	1/6	40	14	6	.....	.....
Cedar Rapids†	Full.	95	16	8	65	3,315
Creston‡	1/6	50	7½	8	.....	500
Freehold†	1/9	.....	12	7½	40	500
Gainesville†	Full.	30	5	6½	.....	450
Laramie†	1/4	200	12	7½	175	3,065
Manitowoc‖	.....	40	12	8½	.....	3,000
Norfolk‖	Full.	60	18	10	35	320
Osceola Mills†	Full.	68	14	6½	.....	1,290
Readsville†	1/3	30	13½	8	38	125
Ravenna†	Full.	50	7	6	51	.....
Springside†	Full.	50	14	12	.....	650
T.-H.‡	2/3	.....	15	8	13	700
Waterloo*	2/3	90	8	8	67	500
Wyoming†	.....	34	12	7	.....	2,000
Columbus*	Full.	200	13	2.1	121	1,527
Carlisle‡	.....	125	13	3.	112	1,300
Greenview‡	1/3	.....	6	2.75	.....	120
Martinsburg*	Full.	70	16	2.7	30	1,200
Salem*	3/4	.....	24	2.1	300	2,600

Places with automatic condensing engines are marked with an *; automatic non-condensing, †; automatic, ‡; Corliss condensing, §; triple expansion, ‖.

The last five stations are evidently working economically, but the others are certainly open to improvement. A 50 HP. station, running its engines at full load, which requires 10 or 12 lbs. of coal per HP. per hour, is probably not paying more than a small part of the dividends which would result from better design or management. Central stations are particularly well adapted for obtaining the maximum possible power from the coal consumed. The loads on the engines vary considerably, it is true, but the variation is the same night after night and can be easily provided for by a careful superintendent. The average amount of coal burnt per horse power per hour in the 60 stations in Mr. SWETLAND'S table is a trifle over 5 lbs. This indicates beyond doubt that a promising field for engineers lies in the design of central lighting and power stations; engines and dynamos of high efficiency are both to be had, the smaller appliances are now well designed, and the present problem is evidently merely to combine these elements in the best manner, a matter of mechanical rather than electrical engineering.

CORRESPONDENCE.

The Brooklyn Bridge Problem.

KANSAS CITY, Mo., Feb. 25, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: The exhibit in ENGINEERING NEWS of Feb. 14, of Mr. LEVERICH'S proposed arrangement of bridge terminals, seems to add certainty to prior proofs that any device requiring trains to cross each other's tracks is inadmissible; and as a corollary that some means must finally be had of utilizing the loop system. You will perhaps recollect that I got a patent (No. 368,420) for a revolving central platform, around which trains circulate, and load and unload without stopping, which you gave just attention enough to say: No good. Now, I have studied on this off and on for some years, and can't see why yet. Can't see why it can't be easily built, or where there is a chance for break-down or failure, and this with a practical experience of 30 years in such work as this would be.

Bear in mind that if it should be stopped for any cause it is then the platform required by the loop system, to which it is simply an addition. I do not look to it as a money-making scheme, for I will dispose of nine-tenths of the patent (to parties who would interest themselves in it

for $90, but I would like to have a chance to place it before a board of competent men, with my reasons for the "faith that is in me." G. W. PEARSONS.

[The difficulty with this general scheme, which has proved an attractive one to many minds before and since, is that it requires a certain agility and coolness of head to enter and leave trains in that way, and that it does not afford time for packing trains full of passengers, nor adequate entrance and exit space. Let our correspondent not look at the problem in the abstract, but make some definite calculations and designs, and we think he will see where the difficulty lies as respects handling such crowds as pass over the Brooklyn Bridge.—ED. ENG. NEWS.]

The Brooklyn Bridge Question.

READING, Pa., March 2, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: Although it is not the wisest of policies to "put in one's ear" the squabbles of others, yet permit me to suggest that, for some cause best known to yourself, you failed to give sufficient attention to the reading of "Dot's" proposed schedule for the Brooklyn Bridge Terminal, else you would have noted that *A* trains followed the B trains at the headway of 20 sec., instead of preceding them, as indicated by your rendering of the schedule in your issue of Feb. 28. This fact will at once demonstrate the practicability of the schedule, provided the times of switching could be reduced to the minimum therein proposed. But if such should be possible, the equivalent headway could be reduced to 35 seconds, instead of 60 as stated in your last issue.

[Our statement of 60 seconds referred to the headways on the present switching system, which could be at once shortened up from 90 to 60 seconds headway if the "Dot" schedule of 120 seconds for the total switching movement were possible.—ED.]

Your objections as to the possibility of collision of trains leaving for the bridge with a 20 sec. headway are very strong. In the issue of the *Railroad Gazette* of Feb. 27, not being cognizant of the figures of that circumstance (the difficulty at the front of the station), I proposed a schedule for an *equivalent* headway of 45 sec., but which was open to the same objection. Out of the 17 observations made at the outgoing platform, the *longest* time to clear the crossing was 28 sec. Your own calculations show that it takes 9.1 sec. to reach it. So that *with a headway of 30 sec.*, in the *extremest* case the first train will have passed the crossing 11.1 sec. before the second arrives at it, and 2 *sec.* before it starts from the platform. With this fact demonstrated, permit me, please, to invite attention to the following schedule for an *equivalent* 45 sec. headway, in which the times allowed for switching are well within the limits at present required: *B* trains wait 55 sec. at incoming and 30 sec. at outgoing platforms, and *A* trains the reverse: time of switching out, 45 sec.; time of "kicking" back, 35 sec.; time to cross and couple on, 10 sec. *A* trains arrive and leave 30 sec. *after B* trains, and *B* trains 60 sec. after *A* trains. The following shows the sequence of events, time counted continuously in seconds;

0	B_1 arrives from bridge.
30	A_1 " " "
55	B_1 pulls for crossing and stub.
60	A_1 " stub.
90	B_1 arrives from bridge.
100	B_1 " on stub.
105	A_1 " "
120	A_2 " from bridge.
135	B_1 " at loading platform.
140	A_1 " " "
145	B_2 pulls for crossing and stub.
150	A_2 " stub.
155 (?)	B_2 " bridge.
180	B_2 arrives from bridge.
190	B_2 " on stub.
195	A_2 " "
195	A_1 pulls for bridge.
210	A_3 arrives from bridge.
	etc., etc.

As it takes 10 sec. to pass over the reversed curve from the switch to the platform, the *B* engine has finished "kicking" its B_1 train at sec. 125. It then moves slowly toward the crossing, and at sec. 135 the A_1 train clears the crossing, giving the *B* engine 10 seconds to run 45 *ft.* and couple on to B_2.

S. W. FRESCOLN.

[Our correspondent is inaccurate in the item queried above; but neglecting the movement given for that item, which is inconsistent with the rest, and filling in (in parentheses) his omitted times according to his apparent intention, his schedule stands thus—the brackets connecting the times which the obstructing movements occupy:

	A TRAINS.			B TRAINS.		
	A_1	A_2	Secs. interval.	B_1	B_2	Secs. interv'l
Arr. inc. pl...	30	120		60	90	
Dep. " " ..	60	150	30	{ 55	{ 145	55
Arr. stub.....	105	195	45	{ 100	{ 190	45
Dep. "	{(105)	{(195)	60	(100)	(190)	60
Arr. out. pl..	{140	{(230)	35	135	(225)	35
Dep. " " ..	195	(285)	55	(185)	(255)	30
Total time in seconds			165			165

In this schedule the fatal defects are as follows:

1. The actual distance which the *B* engine must run is not 45 ft., but nearer to 75 ft., as will be seen by referring to the plan in our issue of Feb. 14 and 28. Our correspondent seems to have forgotten (1) that the engine does not couple on to itself but to the train, and (2) that it must be far enough back from the crossing to fully clear it, with some fraction of an inch to spare.

2. It is utterly impossible to run even 45 ft. over a crossing, and couple on to a train, in 10 seconds after a preceding train has cleared the crossing, while our correspondent's schedule also requires it to have begun motion back from the platform in that interval.

3. There must be at least 10 seconds leeway to operate such a schedule even for an hour, and 30 seconds would be the minimum of practice for the movement to which he allots 10 seconds. The whole schedule is impossible, in that the total movements are shown by 5 years' experience to require at least 180 instead of 165 seconds, even in operating a single system, *i. e.* with the *B* trains, and the crossing difficulties wiped out altogether, *and with two switch engines instead of one to work the single system.* Were the above schedule possible even for the *A* trains only, the present headway with 4-car trains would be only 82½ seconds, a feat which has never been accomplished even for an hour, in spite of the heavy pressure of traffic.

As for the original "Dot" schedule, two readings of his letter are possible. We took the one which came nearest to possibility as the least absurd of the two, and that we chose rightly is sufficiently evident from a comparison of the two following diagrams, one of which (reproduced from our issue of Feb. 14) shows our reading of the schedule, and the other our correspondent's, as also from the fact that "Dot" himself, in his letter published last week, accepts, by implication, our reading of his schedule as correct. The interval of time remaining for enabling the *B* engine to track down and couple on is so absurdly small that no one but our correspondent has ever ventured to suggest it as a practical, working possibility. The time really required for this process may be seen from the fact that two engines are required even to do the switching for a single system on 90 seconds headway. Where the difficulty lies will be apparent from the following average schedule of trains as they now run on 80 seconds headway, as given on page 159 of our issue of Feb. 14.

Time in seconds.	Train 1.	Train 2.	Train 3.
Arr. inc. pl.....	00	80	178
Dep. "	32	121	210
Arr. stub.....	81	170	269
Dep. "	104	193	284
Arr. out. pl.....	137	226	315
Dep. "	178	267	356

It will be seen that after train 1 arrives on the stub, if the engine began kicking it back at once, it would be through kicking at 101 sec., and would then have 20 sec. or more to back down and couple on to train 2. It would then make the second engine unnecessary, and, moreover, shorten up the total present headway from $\frac{178}{2} = 89$ seconds to $\frac{178 - 23}{2} = 77\frac{1}{2}$ seconds. We will only add in conclusion that all this splitting of seconds, though forced upon us, is utterly absurd. Between paper schedules and practical operating possibilities there is a great gap, which the prudent will not seek to cross, and even the foolish cannot cross—very long. —ED. ENG. NEWS.]

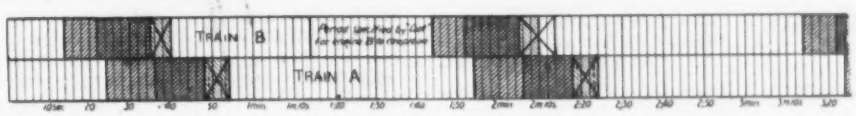


FIG. 1. B trains running 20 seconds ahead of A (reproduced from our issue of Feb. 14).

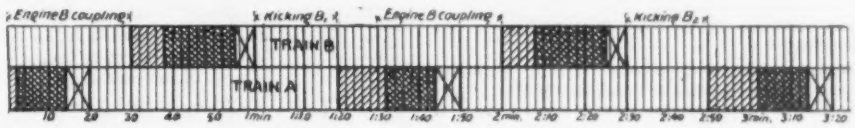


FIG. 2. A trains running 20 seconds ahead of B.

ALTERNATE INTERPRETATIONS OF THE "DOT" SCHEDULE FOR BROOKLYN BRIDGE.

The shaded areas show the movements which obstruct the crossing only, *i. e.*, the run of the A train backing down to the outgoing platform from the stub, and the run of the B trains from the incoming platforms to the stub, as shown in our issue of Feb. 14.

To properly interpret Fig. 2 it is necessary to remember that under present conditions, *i.e.*, with "Train A" only running (the B trip being wiped from the diagram) it is not found possible for an engine starting to kick a train to the outgoing platform, say at 1 min. 20 sec. above, in time to make the A movements only on less than the given 90 seconds headway, so that two engines are employed. Fig. 2 therefore leaves no possible interval for the movements of a switch engine over the crossing, while Fig. 1 does.

The Cause of Failure in the Capitol at Albany, N. Y.

BROOKLYN, N. Y., Feb. 18, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

On reading the report of the Supervising Commissioners of the Albany Capitol for the year 1870, just published, I find the following passage referring to that part of the Capitol wherein the Assembly Chamber is situated. The Commissioners say:

"It has been the general belief that the defective work of this section of the Capitol was caused by the settlement of the foundations. A careful examination fully demonstrates such belief to have been erroneous, and that the foundations of the building are intact, and that the defective work is due to imperfect construction and excessive loading of portions of the superstructure."

In my treatise dealing with "The large grooved vault in the Assembly chamber of the new Capitol at Albany N. Y." (*American Architect and Building News*, Oct. 29 1881), I come to the following conclusions, in consequence of new mathematical examinations:

"The weakness resulting from the variance between the line of the arch and the line of pressure is so great in the ribs of the great vault in the Assembly Chamber of the new Capitol at Albany, that a fall sooner or later is seriously to be feared. Absolute security can be obtained only by tearing down the whole vault and building another in its place."

And, furthermore, in the same paper: "The most extraordinary hypotheses have been advanced to account for this break of the stone and avoid impugning the stability of the arch itself. One suggested that the columns had settled unequally; another that the rib was flattened by the pressure of the half arches held together by the iron tie rods; another that the arch had been warped by the inequality of the weight of the superincumbent vault, etc. A closer examination, however, proves that all these hypotheses are untenable, and that the *cause* of the fracture *can be found only in the vicious construction of the arch itself.*"

In answer to a report furnished by the architects of the Capitol to ex-Governor CORNELL, I also have shown by further mathematical researches (*Am. Arch. Building News*, March 29, 1889) that the maximum stress in the main rib was about 5 times as large as the architects had stated, and that in the same way a great amount of tensile stress (in the weakest cross-sections) was effective, which necessarily had to destroy the stone construction.

I am not going to intrude upon you by further quotations from the voluminous assembly chamber ceiling literature, but I should like to see you out of fairness and justice state by publishing the lines above that with regard to this affair I was right from the very beginning, and have kept right, as has been proven by the very tear-

ng down of the assembly chamber stone ceiling, as well as the report of the capitol commissioners.

If I am allowed to publicly utter another wish, it is this that the building of the capitol may be finished monumentally in stone construction, on a basis of scientific rinciples, and that this sham papier maché ceiling may be replaced also by a monumental stone vault.

H. W. FABIAN, Architect.

Standard Rail Sections.

BALTIMORE, MD., Feb. 25, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I have read with great interest the Progress Report of the Am. Soc. C. E Committee on Standard Rail Sections, published in your issue of Feb. 21. Upon examining the diagrams of proposed sections, I was struck with the similarity of the majority of the sections with one that I proposed for the use of the Baltimore & Ohio Railroad in September, 1888. The proposed section was the result of a careful study during several years, and although not adopted by this company (for reasons I infer of convenience more than anything else), my conclusions have not undergone a change, and I am gratified to see, after a lapse of several years, that prominent members of the Am. Soc. C. E are recommending rail sections that conform in the essential features (viz., small radius of upper and lower corners, vertical sides and width of head) to the one proposed by myself in 1888. An examination of the inclosed tracing will show the similarity as stated.

P. H. IRWIN.

Notes and Queries.

If "Ancient Subscriber"—see page 208 of your issue of the 28th Feb., 1891—will write to W. H. TOPHAM, Esq., General Manager Manchester Ship Canal Works, 65 King St., Manchester, England, he will no doubt be furnished with the address of the maker of the composition used on those works to prevent the adhesion of cement concrete to the sliding panels employed in the construction of the locks, etc. Having seen its use, I can testify to non-adhesion.

HENRY F. PERLEY, City Eng.,
Dept. Pub. Works, Ottawa.

A CORRECTION.—Our attention has been called to an error which crept into the paper on "The Foundations of the Coteau Bridge," by Mr. GEORGE A. MOUNTAIN, Chief Engineer, and published in ENGINEERING NEWS of April 12, 1890. The error lies in making the concrete proportion 1, 1 and 5. Mr. MOUNTAIN writes that the real proportions of concrete used in these caissons were: 1 part of cement, 1 of sand and 3½ parts of broken stone. [ED. ENG. NEWS.]

R. A. asks concerning the practice of measuring dredged material; and when this is measured "in place," how much must be allowed for the portion carried away by strong tidal currents?"—Measuring "in place" under water is only possible under very favorable conditions, if accuracy is in question. In such a case the effect of the current may be disregarded, as the portion carried beyond the dredged area is removed and should be paid for. The levels before and after dredging will fix the quantities approximately. It is better practice to measure the material in scows of known capacity, and by the exercise of proper care the volume can thus be very closely ascertained.

G. H. S. asks for the properties and price of the so-called Spence's metal, and where it can be bought in this country. Spence's "metal" is a compound obtained by dissolving metallic sulphides in molten sulphur. It was discovered by J. B. SPENCE in 1879, and is described in the Journal of the Society of Arts, England, for that year. Prof. ROBT. THURSTON, in his "Materials of Engineering," Part III., describes its properties as follows: On cooling the solution forms a homogeneous, tenacious mass, with a specific gravity of 3.37 to 3.7 at 32° F. The expansion coefficient is small; the fracture is somewhat like that of cast iron. It melts at 320° F.; expands on cooling; resists well the disitegrating action of the atmosphere; is attacked by few acids, and then slowly, or by alkalies; is insoluable in water, and takes a high polish. It makes full, clear castings and is cheap. It has been used as a solder for gas-pipes and in place of lead in making pipe joints. We do not know the price, or where it can be bought, and would thank any one to inform us on these heads.

N. W. W. asks: Will you kindly explain why a 100-lb. rail should have a greater height than a 40-lb. rail? Is it on account of the angle bars. Take, for instance, your 40-lb. rail, which has a neck of 2.11 ins. and your 100 lb. rail, the neck of which is 3.09 ins., a difference of 0.95 in., or nearly one inch, an increase in material of about 10 tons to the mile. It seems to me that there is something radically wrong about the constantly increasing height of heavier sections. Why not use a different joint fastening: 10 tons at $35=$350 per mile, or say $1 per joint? This, added to the cost of the ordinary joint fastening, ought to give us something good.

[The main, if not the only, object in adding weight to rail sections is to add to the strength and stiffness, which increases as the square or cube of the depth. Our correspondent has entirely wrong ideas on the subject. If he will read Chapter XXII. of "The Economic Theory of the Location of Railways" on "Light Rails and Light Railways," he will see more clearly how his argument is defective.]

Potomac River Improvements at Washington, D. C.

From the annual report of Lieut.-Col. PETER C. HAINS, Corps of Engineers, U. S. A., to the Chief of Engineers, for 1890, we abstract the following relating to present and proposed improvements in the Potomac River at Washington, D. C.:

Under the act of Congress of 1882 a plan was adopted for improving the navigation of the Potomac River by filling up the flats in front of the city to a height of 3 ft. above the flood line of 1877, and otherwise improving the river channel. This plan also contemplated the rebuilding of Long Bridge over the Potomac. The amount expended up to June 30, 1889, upon this work was $1,423,764, or rather more than half of the estimated cost of the entire work. At the date named a channel 350 to 550 ft. wide and 20 ft. deep at low water had been dredged between Georgetown and Giesboro Point. The channel below Long Bridge had maintained its full width and depth, but the part above had shoaled to about 14 ft. at low tide. The Washington channel had been dredged to a depth of 20 ft. and width of 350 ft. The material removed had been deposited on the flats and 544 acres had been raised above overflow at ordinary high-tide. Of the total quantity required to fill the flats to the height proposed, a little more than one-half had been deposited.

The necessity for the immediate reconstruction of the Long Bridge is pointed out. The bridge now there has too many piers, and these are set in such a manner that they obstruct the flow of water. The fact that these piers are built on timber platforms, with mounds of rip-rap about the base, still further obstructs the current. Col. HAINS says that it is of the utmost importance that the bridge over the main channel at least should be rebuilt without further delay. The iron bridge over the eastern branch of the Potomac River, at the foot of Pennsylvania Ave. southeast, was finished in March, 1890. This bridge was contracted for in 1887 with the Groton Bridge & Manufacturing Co., of Groton, N. Y., for a total price of $105,000. Owing to trouble with the Baltimore & Potomac R. R. Co. at the west end some delay occurred, and an additional price of $40,000 was to be paid the contractors for substituting two 151 ft. through spans for the one 90 ft. through span and two 112 ft. deck spans, as originally proposed.

In obedience to an order from the U. S. Senate, directing him to report upon the most suitable kind of a bridge across the Potomac, connecting the foot of New York avenue with the U. S. National cemetery at Arlington, Colonel HAINS reports as follows: Owing to the undesirable features of a drawbridge and the necessity for a clearance of about 100 ft. in the channel, a suspension bridge is recommended. The preliminary design given in the report shows a river span of 1,100 ft. and a clearance of 105 ft. in mid-channel. The two shore spans would be 652 ft. long with approaches of arched masonry and earthen embankment. The suspension cables would be of steel, passing over towers 210 ft. high. The grades would be 3% on the central span and 3.5% on the shore spans, with 4% on the approaches. The bridge would be 54 ft. wide, with a 34 ft. roadway. The general design given is almost identical with the Brooklyn Bridge in the towers and general approach plans. The approximate estimate of cost is $3,591,000.

Testing Portland Cement with Hot Water.

A French engineer, M. DEVAL, who is in charge of the testing bureau of the Paris public works department, has been making some extended experiments on the use of hot water for immersing cement briquettes before testing. The briquettes tested had a cross section of 5 sq. cm., and were composed of mortar made with one part by weight of cement to three of sand, mixed with the minimum amount of water. The briquettes were allowed to harden in air for from 24 hours to 30 days, and some of them were then placed in water at 80° Cent. (177° Fahr.) in and kept there 2 to 7 days, while others were kept in cold water from 7 to 28 days.

Six brands of Portland cement were tested in this manner, and it was found that Portland cement of good quality resisted the action of water at this temperature and attained about the same tensile strength in 7 days when immersed in hot water as it gained in 28 days when cold water was used. If the setting of the cement was not complete before the immersion, it was found that the cement invariably disintegrated when put into the hot water.

The most important result, however, was the action of the hot water on cements containing free lime. Where the percentage of free lime was large, the briquettes cracked, swelled or disintegrated while immersed in the water; smaller proportions of free lime reduced the tensile strength of the cement below that of the same cement immersed in cold water.

The presence of caustic lime, as is well known, is one of the most frequent causes of failure of cements. The lime is slacked by the water and swells, causing general loss of strength or local cracking, according to the amount of free lime and the degree to which it is incorporated with the cement. In testing cements it is not always that time enough is available for testing by the usual process to detect the presence of free lime. Some cements which show fair results on short time tests, afterward deteriorate and lose strength by the gradual hydration of the quicklime. The use of hot water doubtless hastens the hydration of the quicklime, and any deleterious action is more quickly developed.

Experiments made by W. W. MACLAY, and described in a paper read in 1877 before the American Society of Civil Engineers, showed a marked increase in the rapidity with which Portland cement gains in strength by immersion in water, when the water was moderately warm, over the strength of the same cement immersed in cold water. The temperature of the water used in Mr. MACLAY'S experiments varied only from 40° to 70° Fahr.; but, so far as it goes, this result seems to confirm the conclusions reached by M. DEVAL.

The most important use of the hot water test would seem to be in testing new brands of cement. In this connection, indeed, the use of hot water for immersion is not entirely unknown to American engineers. BAKER, in his "Masonry Construction," advises heating the water of immersion to 100° Fahr. in making tests of the soundness of cement. That it is well to increase this temperature to a point approaching the boiling point seems to be indicated by M. DEVAL'S experiments. It is to be hoped that further experiments in this direction may be undertaken by American engineers in order that M. DEVAL'S conclusions may be verified, and fuller particulars concerning the application of his process may be placed at the disposal of the profession.

Legal Decisions of Interest to Engineers.

Danger Signals for Street Excavations.—A city is under no legal obligation to provide danger signals along an excavation in a public street, as to one traveling outside of the street, or except at the crossings or intersections of such street by other streets or highways, and when a person, in driving over a vacant lot or tract of ground, is precipitated over an embankment into the street and injured the city is not liable in damages for such injury. (Mulvane v. City of South Topeka, Sup. Crt. of Kansas, 25 Pac. Rep., 217.)

Injury to Passenger by Careless Car Coupling.—Where a child is injured by being thrown against the back of a car seat, as the result of a severe concussion caused by violently backing an engine against the train, which injuries so sustained resulted in permanent injury to his health, a verdict for $5,000 is not excessive, and the fact that the engine was backed against the train by an employé without authority to do so is no bar to recovery. (Richmond & D. Ry. Co. v. Childress, Sup. Crt. of Georgia. 12 S. E. Rep., 301.)

Responsibility of Flagman at Railroad Crossing.—Where a flagman is stationed at a crossing by a railroad company to give warning of the approach of trains, persons desiring to cross the track have a right to rely upon the reasonable performance of his duties by the flagman, and are not charged with the duty of looking and listening for a train before attempting to cross. It is not in itself negligence for a person to cross a railroad track on the public highway, where there are a large number of side tracks, when by going a few blocks out of the way a safer place of crossing might be found. In order to relieve the company from liability, or charge the traveler with negligence where it appears that the crossing gates were not lowered, and no signal was given by the approaching train, but it is claimed that the flagman signaled the injured person not to cross the track, it must be further shown that the signal given was made in time to give the traveler time to act upon it.—(Chicago R. I. & P. Ry. Co. v. Clough, Supr. Ct. Ill, 25 N. E. Rep. 664.)

Fluctuations in Manufactured Iron and Steel Prices, 1881-1891.

The *Iron Age* published in its last issue a diagram which we reproduce herewith in a somewhat modified form, showing the fluctuations in the Chicago prices of bar iron, sheet iron, cut nails, wire nails and barb wire. The chart indicates the fluctuations in the average prices of all these, from week to week, as shown in the *Iron Age* quotations. All prices are for carload lots, f. o. b. Chicago. The bar iron quoted is common merchant iron; the sheet iron is No. 27 common black; the nails are as indicated in the captions over the columns; the barb wire is painted four-point. Prices are per pound throughout, except nails, which are quoted, as is customary, per keg of 100 lbs.

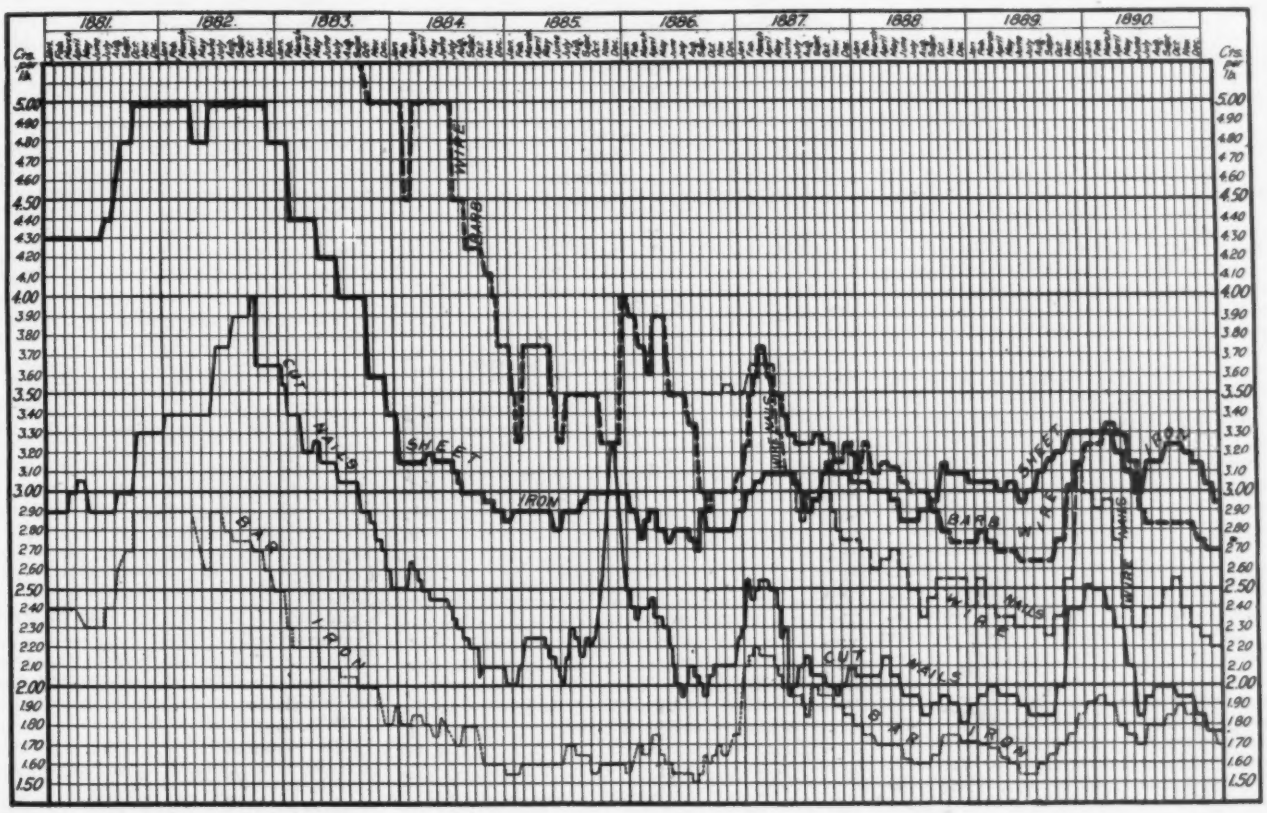
The course of prices in 1884 was affected by a panic in railway securities which occurred in May, and speedily affected all branches of business. The demand for iron products fell decidedly, and prices receded to lower depths than had before been known at Chicago. There was a steady decline until the close of the year. At that time old iron rails were abundant and very cheap, and were largely used in the manufacture of common iron. It will be noted further that sheet iron and nails fell in price in about the same ratio as bar iron. This year marked the first appearance of cut steel nails as a regular commercial product, although they had been manufactured in a small way in 1883 by several factories They were sold at 10 to 15 cents per keg above the price of iron nails. Their use in the West increased very rapidly from 1884, and in 1887 they almost wholly supplanted iron cut nails. The reduction in the price of barb wire was very marked in 1884, due to the competition of wire upon which no royalty was paid to the patentees.

The year 1885 was a period of gradual recovery from the depression of 1884. It was particularly marked by a strike among Western nailmakers, which caused a scarcity of nails for a time, resulting in a rapid advance in their price. In 1885 the wire nail secured a foothold in the trade, but it was not until 1886 that regular quotations were made. In 1886 and 1887 jobbers carried full stocks of three kinds of nails—iron and steel cut nails and wire nails.

Collecting the average price for each of the years shown, and adding for the purpose of comparison the average prices for the month of January, 1891, the *Iron Age* gives the following comprehensive exhibit for the decade:

YEAR.	Bar. iron.	Sheet iron.	Cut nails.	Barb wire.	Wire nails.
	Cts.	Cts.	Dolls.	Cts.	Dolls.
1881	2.55	4.55	3.03	8.00	.....
1882	2.76	4.96	3.60	8.00	.....
1883	2.08	4.10	3.08	6.27	.....
1884	1.73	3.06	2.33	4.52½	.....
1885	1.61	2.93	2.38	3.49	.....
1886	1.66	2.82	2.18	3.41	3.51
1887	2.00	3.05	2.50	3.35	3.15
1888	1.69	3.00	1.96	2.97	2.55
1889	1.68	3.21	2.05	2.81	2.49
1890	1.82	3.17	2.05	2.97	2.52
January, 1891	1.70	2.95	1.75	2.70	2.22½

It will be seen from this table that 1882 was the year of highest prices in the decade. Present prices are below the average, and those of cut nails, barb wire and wire nails are the lowest recorded.



CHICAGO PRICES OF BAR IRON, SHEET IRON, CUT NAILS, WIRE NAILS, AND BARB WIRE FROM 1881 TO 1890.

The Nomenclature of Brick.

At the fifth annual convention of the National Brick Manufacturers' Association, held in Indianapolis, Ind., a report was received from a committee appointed to consider the nomenclature of brick, with the purpose of adopting some standard nomenclature for all localities. This committee was composed of Messrs. W. A. ENDALY, D. V. PURINGTON and WILLIAM H. BRUSH. The committee sent letters to all the important brick centers in the country, and from the full replies received they describe some of the leading kinds of brick, with the names applied to each in different localities, and the name recommended by the committee. The committee ask that the subject be further reported upon at the next convention. The substance of the present committee report is as follows, as taken from the *Clayworker* of Feb. 5, 1891:

THE NOMENCLATURE OF BRICK.

Salmon Brick.—Brick not hard enough for the outside of outside walls now variously known as "Soft," "Salmon," "Backing-up," "Pale," "Light," "Chimneys," "Filling in," "Inside Wall," and "Foundry" brick. Anything softer than salmon brick is not, properly speaking, a brick.

Hard Kiln Run.—Brick burned hard enough for the outside of outside walls, not selected, now known as "Hard," "Common Building," "Paving," "Hard Building," "Outside," "Hard Red," "Strictly Hard," "Select Hard," "Rough Hard," "Hard Washed," "Kiln Run Hard," "Common Hard," and "Kiln Run Hard, one-half smooth, one-half rough."

Arch Brick.—Brick set from the top of the arches to the bottom of the kiln now known as "Arch," "Bench," "Eye," "Over-hangers" "Foundation," "Cistern," "Cellar," and "Hard Rough" brick. All brick set in the arches or benches which are *discolored*, *broken* or *twisted* in the burning, as

Front Brick.—No. 1, light burned; No. 2, medium burned; No. 3, hardest burned. Brick selected for the fronts or the outside of outside walls now known as "Fall," "Outside," "Select Common," "Reds," "Hard Fronts," "Fronts," "Veneering," "Smooth Hard," "Straight Hard," "Common Fronts," "Light Hard," "Chimney Tops," "Liners," "Select," "Select Reds," "Headers," "Stretchers," "Dark Fronts," "Stock," "Select Hard," "Side and Back Walls" and "Croton Front Brick."

Sidewalk Brick.—Brick used for sidewalks now known as "Pavers," "Sidewalk," "Hard," "Selected Hard," "Hard Burned," and "Yard Pavers."

Sewer Brick.—We recommend that this term shall mean good, straight, hard burned brick.

Foundation Brick.—We recommend that this term shall mean a good, hard, well burned, but not selected brick.

Merchantable Brick.—All the brick in the kiln (not strictly soft) now known as "Kiln Run," "Merchantable (one half select and one half soft)," "Merchantable (one-third select, one-third hard and one-third soft)," "Building Brick," "Common Building," "Average Brick," "Two thirds Front, one-third Salmon."

Front Brick.—In two or three localities brick molded in sand by machine or hand, not repressed, but handled with extra care, burned in the best part of the kiln and well selected for fronts, now called "Headers," "Stretchers" and "Croton Fronts."

Kiln Run Brick.—All the brick that are set in the kiln when burned.

Rough Kiln Run.—All the brick left in a kiln after the "Front Brick," "Sidewalk Brick" and "Sewer Brick" are taken out of the kiln, now variously called "Inside Brick," "Sewer," "Cistern," "Inside Walls," "Double Coal," "Shrunkery," "Clinkers," "Rough Kiln Run" and "Backing Up."

Press Brick.—Brick made especially for the fronts of buildings, by repressing or dry-pressing, now known as "Pressed," "Repressed," "Stock," "Fronts," "Sand Pressed," "Dry Press," "Line Brick," "Stretchers," "Headers" and "Face."

We further recommend that press brick be graded as follows:

First, as to color: The numerals (No. 1), (No. 2), (No. 3), (No. 4, etc.), shall designate color; (No. 1) being the lighter shade and (No. 2) the next shade darker, and so on for any number of shades.

Second as to the quality: Press brick shall be designated by the ordinals, as "First" grade, "Second" grade, "Third" grade, and so on.

We then have press brick: (No. 1) First grade; (No. 2) First grade, and so on for any number of shades. (No. 1) Second grade; (No. 2) Second grade, and so on for any number of shades. (No. 1) Third Grade; (No. 2) Third grade, and so on for any number of shades or qualities.

The numerals always denoting the color or shade, and the ordinals always denoting the grade.

Extremely light shades may be known as No. 0, and No. 00.

We further recommend that all dry press or repress brick not selected for fronts, be known as common brick, and be subject to the same classification.

Stock Brick.—The term "Stock Brick" is applied to a brick molded, either by hand or machine, in rough, coarse sand, and repressed without rubbing, so as to give the brick a rough sand finish.

Ornamental Brick.—A great variety of names applied to molded or ornamental brick, among which are the terms, "Stretchers" "Headers," "Bay-window," "Trimmers," "Cornice," etc. We recommend that brick other than square brick be known by this term.

The terms "Headers" and "Stretchers" are often applied to the manner in which the green brick are set in the kiln. As you enter the kiln you see the ends of the "Headers" and the sides of the "Stretchers."

"Platting," "Splatting" and "Flatting" are terms applied to one or more courses of brick placed on top of a green kiln to hold the heat when burning. These brick are often set on edge, or laid singly flat, as in paving, and often two courses are laid flat, one above the other. We recommend that all brick used to cover the top of a green kiln set for burning be designating as "Platting."

Methods of Railway Car Lighting.

At the last meeting of the Western Railway Club a paper on the above topic was read by Mr. GEO. GIBBS, Mechanical Engineer of the Chicago, Milwaukee & St. Paul Ry. Eight different methods were described, but most of the paper was devoted to the electric system, the Pintsch compressed-gas system, and the Frost gasoline system. We condense the description of the less important systems below:

Candles, though now obsolete, were considerably used 15 years ago in the United States. In 1887 the German state railways had 2,420 cars lit with them.

Vegetable oils are in use on some foreign roads. Rape-seed oil is the most common. The reason for their use abroad is probably the high price of petroleum.

Petroleum may be said to be *the* illuminant in American railway service. Up to about 10 years ago the oil used corresponded to the low fire-test oil now used for household purposes, firing at 150° Fahr. and giving off inflammable vapor at 110°. Improved processes of oil refining and improved burners have now made possible the use of a heavy high-test oil with a fire test of 300° and giving off no inflammable vapor below 230°.

Ordinary coal gas was first used on the underground railways of London, being stored in weighted rubber bags on the car roofs. This clumsy method was soon abandoned. In this country the Pennsylvania has been the only road to adopt compressed coal gas extensively. It was their standard method for lighting main-line cars until the carbureted-air plan was substituted. [Coal gas, stored in collapsible rubber "bellows" reservoirs in the baggage cars, is in use on the North London Ry.—ED. ENG. NEWS.]

Carbureted coal gas.—An objection to ordinary compressed gas is the small amount of light given out in proportion to the bulk of the gas. The Belgian state railways have adopted the plan of enriching the common gas by passing it through vessels containing gasoline or naptha. This about doubles its efficiency as an illuminant. The system has been adopted for sleeping cars by other European railroads.

"Rich" or oil gas has been in use abroad for many years, notably on the Belgian and German state railways. It is stated that 35,000 cars in Europe are equipped with this system. In America also this system, as represented by the Pintsch, is making rapid headway, nearly 2,000 cars being fitted with it to date. Mr. GIBBS describes the Pintsch system as follows:

The Pintsch system has largely confined its attention to producing more efficient gas, which, it is claimed, is supplied by the use of a rich, permanent "oil" gas. Ordinary city or coal gas when burned at pressure of the street mains, 1 to 1½ oz., may be taken to give an illumination of, at the most, 4 candles per cu. ft. Oil gas at the same pressure will, it is claimed, give from four to six times as much, say, 16 candles per cu. ft. But one property of gas which vitally affects the problem is the loss of light-giving power upon compression and storage. This is true of all gas, and is due to the deposition of the rich, oily hydrocarbons, but is not true to the same extent for oil and coal gas, the difference being materially in favor of oil gas. Reliable tests have shown that coal gas loses 50% and oil gas 21% of light-giving power upon compression to 300 lbs. per sq. in.; and at 225 lbs. per sq. in. the quantities required for equal illumination would be about 5 of coal gas to 1 of oil gas.

The material used for the manufacture of Pintsch gas is crude petroleum. The generation of gas is effected by vaporizing the oil at a high heat in suitably arranged cast-iron retorts, the process of manufacture being, on a small scale, essentially that followed for city gas. From the storage tank, pipes and rubber hose connections lead to convenient places for filling the car tanks. A plant capable of making sufficient gas for 5.0 cars is contained in a one-story building 23 ft. × 38 ft.

The outfit on the cars consists of one or two cylinders for holding the compressed gas, a pressure regulator and system of piping to the lamps. These are of special design, each having from four to six flames arranged beneath a porcelain reflector, the whole encased in a glass bell jar; ventilation is suitably provided for, and a very steady and shadowless light is obtained.

Mr. GIBBS made estimates of the cost of equipping the Chicago, Milwaukee & St. Paul system with central station plants for the generation and storage of Pintsch gas. He found that the company had 570 cars in active passenger service; all but 104 of these could be supplied with gas from seven distributing points, and 376 cars could be supplied by erecting stations at only three points. The cost of the gas-works is as follows:

	Apparatus.	Building.	Total.
To supply 500 cars.....	$11,000	$4,500	$15,500
" " 200 "	9,500	4,100	13,600
" " 100 "	7,500	3,000	10,500

On this basis he estimated that seven works could be established at a cost of $84,700, or $181.75 per car supplied; or the three works could be built for $42,700, or $114 per car supplied.

CARBURETED AIR.

The seventh method of car lighting described by Mr. GIBBS is that in which air charged with the vapor from gasoline is used as the illuminant. The only instance found of its use abroad was on the London, Brighton & South Coast Ry., where, however, it was soon abandoned on account of its danger and the difficulty of regulating the quality of the gas. In this country the principle has recently been employed in what is known as the "Frost" system, which was described as follows:

The amount of gasoline vapor absorbed by air depends upon its temperature; thus, at 14° Fahr. about 6%, and at 68° 27% will be taken up. This is, however, a mechanical mixture only, and not a permanent gas.

The vapor thus formed is capable of being burned like gas when mixed with air in the proper proportions, giving a highly luminous flame.

The difficulties to be overcome in using this agent for safe car lighting are, first, the presence of liquid gasoline. The Frost system overcomes this objection by filling the carbureting vessel almost completely with wicking, and by merely saturating this with the gasoline, draining off the superfluous liquid. Second, the effect of variation of temperature in the amount of vapor absorbed by the air current. Thus, in cold weather only a small percentage of gasoline is absorbed, too little to produce a good light and in warm weather too much, producing a rich but smoky light. This is really the serious stumbling block to all schemes of this kind. The Frost system claims to entirely overcome it by placing a small generator or carbureter above the light on the roof of the car, in such a manner that a portion of the heat generated by the burner is transmitted to the carbureter, insuring a uniform temperature at all times.

The system in detail consists of an air storage tank underneath the car, containing sufficient compressed air to supply light for six hours. This compressed air is obtained directly from the train pipe of the air brake, and is led through a suitable pressure reducer and a regulator to the carbureters in the roof, one of these being placed over each lamp, and thence, after passing through them, to the lamps underneath. These are now constructed on the "Siemens" or "regenerative" principle, and give a brilliant white light without shadow. The supply of gasoline in the carbureters is sufficient for 43 hours' burning, and then can be recharged by filling from the roof.

ELECTRIC LIGHTING.

This was referred to as the newest method of train lighting. The various systems are as follows:

1. Primary batteries.
2. Secondary batteries or accumulators.
3. Dynamo machine connected to car axle, with or without accumulators as auxiliaries.
4. Dynamo operated by special steam engine, either in a car or on the locomotive, and supplied with steam from locomotive or special boiler on a car; accumulators either used or not, as desired, as equalizers.
5. Electric current supplied to the train by contact with wires along the track.

Primary batteries have been tried in England and France. The result in every instance was flat failure; and this will always be the case with present forms of primary batteries. The electrical energy furnished by the zinc or other metal burned with other chemicals will be, at the lowest estimate, forty times as expensive as that produced by the steam engine and dynamo.

Storage batteries were used extensively for five years on the London, Brighton & South Coast Ry. It this country the Pennsylvania (for the Pullman cars of the "Limited"), the Boston & Albany, and the Chicago, Burlington & Quincy all had them in use for some time. In all these cases the system has been abandoned; but it is said to be still in use, to a limited extent, on the Canadian Pacific, the Burlington, Cedar Rapids & Northern and on some parlor cars on the Pennsylvania Railroad. The weight of batteries required for a standard coach lit by this system is about one ton.

Dynamos connected to the car axle have been very favorably regarded by inventors. The London, Brighton & South Coast Ry. has had this system in successful use for a long time. The main difficulty experienced abroad, where the system has been thoroughly tested, is the transmission of power from the axle to the dynamo. This would probably be a greater difficulty with the American bogie truck than with European cars with their rigid wheel base.

Dynamos operated by a special steam engine have not found favor abroad; but here the system is the only prominent one. The Connecticut River road was probably the first to use it, and among those who have it now in use are the Pennsylvania, the Atchison, Topeka & Santa Fe, the Chicago, Milwaukee & St. Paul and the Union Pacific. In all the above, storage batteries have been used for reserve. The use of dynamos without batteries was tried in 1884 on the London Underground Ry. without much success, and has also been tried in Germany. It is the system now in use on the Chicago, Milwaukee & St. Paul.

Electric currents taken from a track wire are used in a number of places in England and Russia to light trains when passing through tunnels. The method is obviously adapted only to special uses.

ELECTRIC LIGHTING ON THE CHICAGO, MILWAUKEE & ST. PAUL.

This road has without doubt experimented in train electric lighting on the largest scale of any railway in the world. The first system tried consisted of a small engine in the baggage car, taking steam at 60 lbs. pressure from the train heating pipes, and coupled direct to a 100-light dynamo. Under each car were 32 cells of storage batteries, weighing 1,500 to 2,000 lbs. The lights could be run from the dynamo, from the batteries, or from both simultaneously.

This outfit was very carefully arranged and worked very well, but the company was quite willing to abandon it. The serious defects were the deterioration of the storage batteries (estimated at about 40% per annum), the complicated arrangements requiring skilled attendance, with poor economy of the engine and, in fact, of the whole apparatus.

After a year's trial this system was abandoned and the present system was adopted. Storage batteries were done away with, and the light was generated directly by a dynamo run by a steam engine. It was considered best to do away with special types of engines and dynamos, and use standard apparatus of proved efficiency in stationary work. The plant consists of a 15-HP. Westinghouse automatic engine, taking steam from the boiler at 60 lbs. press-

ure, and belted to a 150-light Edison compound-wound dynamo. In summer this outfit is placed in the end of the baggage car, occupying about 12 ft. in length of the car. In winter the drain on the locomotive boiler for both heat and light proved a serious matter on heavy trains, and a special car was built to carry the lighting and heating apparatus. It was found that at least 12% of the steaming capacity of the locomotive was required for heating and lighting a 10-car train with the thermometer not below zero, while to haul the extra car not more than 6% additional was required. Furthermore, the drain upon the locomotive for lighting and heating was a dead loss of so much steam, adding nothing to the capacity of the furnace to burn more fuel, while the extra power developed in the engine cylinders produced further means for urging the fire.

The "light and heat tender" contains a locomotive-type boiler, coal bunkers with fuel capacity for 500 miles run, tank containing three hours' water supply, engine, dynamo and the various fittings necessary for regulating the supply of heat and light to the train. The whole is under the charge of one attendant, who fires the boiler, runs the engine and dynamo, and regulates both heat and light supply.

The electrical equipment of the Chicago, Milwaukee & St. Paul now comprises 62 cars lit by electricity and 2 light and heat tenders. The total number of lamps supplied is 1,128. The 62 cars include 8 baggage cars, 9 mail and express cars, 15 first-class coaches, and 30 sleeping, parlor, dining and chair cars. The sleeping cars have 34 lamps each. The first-class coaches have 12 lamps each. Four through trains are lighted each night; the tender cars are used for the heaviest service, between Chicago and Minneapolis.

(To be continued.)

Standard Methods of Testing Materials.

For many years the subject of uniform methods of testing materials has been before the American Society of Mechanical Engineers. A committee was appointed to formulate a uniform code in 1885, and in 1886 sent out specimens to 24 testing laboratories located at the principal steel, iron and bridge works and some of the leading colleges.

At the New York meeting in 1889 the committee made a preliminary report, in which the results of these tests were given. It was then stated that it seemed desirable on the whole to adopt international standards. One member of the committee during two years abroad had given much time to examining the methods of testing in use in different countries. It was found that in France the use of testing machines is limited, except for government work, and there is no uniformity of method. In Great Britain the use of testing machines is much more general, but there is no approach to uniformity, and the observations taken are meagre, except in the case of tests by leading engineers. In Belgium testing is more general than in France, but no progress toward uniformity has been made.

In Germany the practice of testing is more common, and is more scientifically conducted than in any other country. During the last decade German manufacturers, engineers and professors have united with their fellows in Austria, Switzerland, Russia and Denmark in the adoption of standard forms of test pieces and methods of testing. Several meetings have been held, and the standards recommended have been practically universally adopted in the five countries.

The reports of the various conferences by which these standard methods were proposed have been collected by an international committee, and their report was translated by Mr. Gus C. Henning, a member of the American Society's Committee on Uniform Tests. This translation was printed as appendix II. to the preliminary report of the committee, and was presented at the Cincinnati meeting in May, 1890.

Evidently there was no need of Americans duplicating the work which had already been so thoroughly done by the painstaking Germans and their neighbors, and it was certainly desirable that the proposed American system of standard tests should conform to that already perfected and adopted by five nations of Europe, so far as could be done without interfering with the methods already in general use in this country. The committee, therefore, took as a basis those features of American practice which are in extensive use, as well as the European code referred to, and prepared recommendations for an American standard code of rules for conducting tests of material with scientific accuracy.

It is to be noticed that this proposed standard code is not intended to apply to ordinary routine or shop tests, such as are made, for instance, in every steel works of importance, or by the testing laboratories of railway companies in examining the regular supplies. It is intended only for tests where a fair degree of scientific accuracy is to be attained; and where tests are made a matter of record. Such tests, made according to a standard code, can be readily compared with each other, no matter when or where made. It may be said here, however, that it is the intention of the committee to prepare as soon as possible recommendations for a standard code of shop and routine tests.

The code for scientific tests, as prepared by the committee, has been published in the proceedings as a preliminary report. Criticism and suggestions concerning it are invited from all engineers interested. With the aid of these suggestions, such changes as seen advisable will be made, and the report will be submitted to the society for discussion and adoption.

The ground covered by the code is the testing of iron, steel and other metals, and the testing of woods. The recommendations for testing stone, brick, mortar and cements, which form part of the German standard code, were not included by the committee. Any uniform system of testing these should properly originate with the American Society of Civil Engineers. It may be said here that it would be altogether proper to ask the co-operation of the American Society of Civil Engineers in the adoption of any standard code for testing iron and steel, since the testing of these materials is carried on fully as much by civil engineers as by mechanical engineers.

The first part of the proposed code contains general recommendations concerning testing machines and appliances. In the second are given the proper tests to be applied to the principal commercial forms of iron and steel and to cast-iron, copper, bronzes and other metals, and to woods. The third part gives detailed directions concerning the making of each different kind of test, and the fourth describes the standard shape of test pieces for each sort of test required.

Concerning testing machines, the principal points insisted on are facility of calibration, the application of stress without impact and holders so made as to apply the stress uniformly over the entire area of the test piece. Serrated wedges which cut the test pieces are to be avoided. For flat bars in tension, pin hole and pin connection are advised.

For drop tests a standard apparatus is recommended, having a cast-iron or steel ball weighing 1,000 to 2,000 lbs., and of such a shape as to bring its centre of gravity near the base. On its lower side a forged steel striking block is to be attached by a dovetail and wedges, and this striking face is to be a plane normal to the vertical axis of the ball. The weight of frame, bearings and anvil block should be at least 10 times that of the ball, and the whole is to be mounted on a masonry foundation. The guides should permit a clear fall of 20 ft. They should be of metal and lubricated with graphite. Upon the anvil are to be placed bearing blocks of a shape to suit the article to be tested.

The tests recommended for different materials are as follows:

Rails.—Drop test and bending test, with tension test if further knowledge of the material is desired.

Axles. Drop test, with tension test for further knowledge.

Tires.—Drop test, with tension test for further knowledge.

Structural Iron.—Tension, bending and welding tests.

Mild Structural Steel.—Tension and bending tests, with welding, hardening, and annealing test if the metal is to be used for welded members.

High Structural Steel.—Tension, bending and hardening tests.

Boiler Iron.—*Plates* by tension, forging, and punching tests and bending cold and hot. *Shapes*, the same with welding test if shape is to be welded in use. *Rivet rods*, by tension, bending and forging tests.

Boiler Steel.—Tension, hardening and forging tests and bending hot and cold.

Ship Material.—*Plates*, tension and cold bending tests. *Shapes*, tension and hot and cold bending tests. *Rivet Iron*, tension, bending and forging tests.

Wire.—Tension and winding tests and test by bending back and forth around a turned stud of same diameter as the wire.

Wire Rope.—Tension and longitudinal impact tests.

Cast Iron.—Tension, bending and compression tests.

Copper Alloys and Soft Metals.—Tension and compression tests.

Woods.—Tension, compression and transverse tests.

Among the recommendations as to the method of testing is that material should be tested as it comes from the rolls or mold when it is to be used in this shape. By this means the influence of the skin of the metal to strengthen or weaken will be given its proper value. Great stress is laid on the careful preparation of test pieces to avoid all nicks, bruises or scratches. "The slightest blow of a hammer or simply dropping pieces on metal or stone are frequently causes of most erroneous results."

TENSION TESTS.

The principal recommendation here at variance with the ordinary system of testing concerns the measurements of elongation. The test piece is to be divided between gage marks into half-inch spaces.

Suppose the number of these spaces to be 16, and that fracture takes place at a point nearest a division 5 spaces from the left gage mark. Then the actual elongation is measured of the length of 10 spaces having the gauge mark near the center. To this is added double the elongation measured on the 3 spaces next to the right of the 10 spaces. The reason for this change is that the ordinary method of measuring elongation between the gage marks is correct only when the fracture occurs midway between them.

The test is to be made by applying stress steadily and uniformly, stopping at intervals only long enough to measure the elongation. The elastic

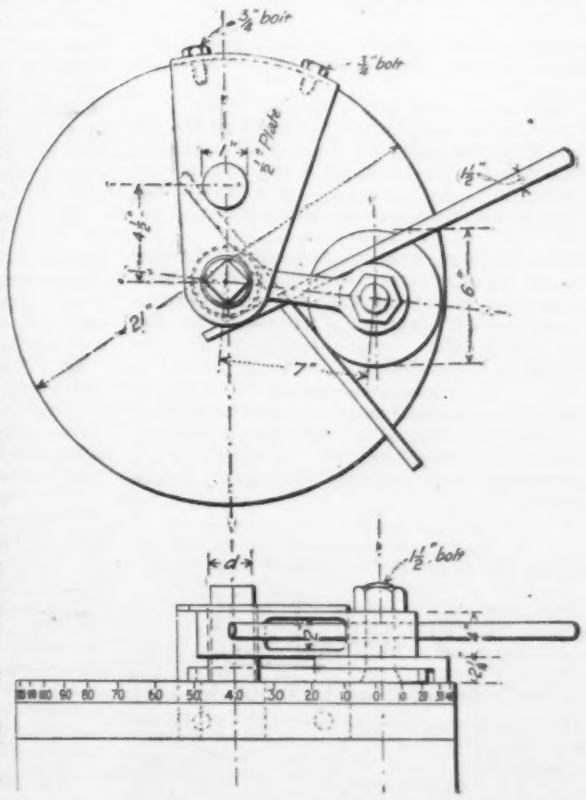


FIG. 1. SKETCH OF MACHINE FOR MAKING BENDING TESTS.

limit is to be determined with even greater care than the ultimate strength.

The maximum load is to be the highest load carried by the test piece, and this is taken as the ultimate strength per square inch, no allowance being made for the reduced cross-section of the specimen when it sustains the heaviest strains.

COMPRESSION TESTS.

The principal novelty here is the recommendation to use long test pieces, 10 to 20 diameters in length as well as cubes and cylinders. The committee holds that long pieces carefully tested will pass the elastic limit before they will fail by buckling.

TRANSVERSE TESTS.

Very sharp knife edges are to be avoided, and the use of rolling bearings is recommended, as they do not cause a tensile strain in the piece when it deflects.

TORSION TESTS.

Particular care must be taken to have the body and ends of the test piece concentric, and the strain must be applied tangentially to the piece.

WELDING TESTS.

A piece of metal with section about 1 in. in largest dimension is to be prepared for a single scarf weld and heated in a reducing flame in a clean fire. At a white heat it is to be removed and welded with an 8 to 10 lb. hammer, then upset while still hot, and finally drawn down under the hammer to its original size. No flux and no water are to be used. One bar welded in this way is to be tested in tension; another is to be nicked to the depth of the weld and bent or broken, if possible, to show the character of the welded surfaces.

BENDING TESTS.

These are valuable because so readily applied; but the common method of sticking the test-piece into the jaws in a vise and striking it with a hammer is condemned. The machine illustrated in Fig. 1 is to

Fig. 2. Standard Shape for Tension Test Piece. Round Specimen.

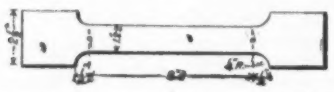


Fig. 3. Standard Shape for Tension Test Piece. Flat Specimen.

be used, the stud about which the bending takes place being twice the thickness or diameter of the test-piece.

HARDENING TESTS.

These are to be made by heating a test-piece to a red heat and plunging into water at 32° to 40° Fahr. With the bending-test machine this piece is to be tested, and its results compared with those of the same test on a similar piece not hardened.

FORGING TESTS.

This test is chiefly of use for rivet rods. A part of the rod is brought to a fair red heat and hammered until cracks barely begin to show at the edge of the piece. The amount of flattening which the piece stands before cracks appear shows the red-shortness of the material.

PUNCHING TESTS.

These are made by measuring from the finished (not rough sheared) edge of the plate to the near edge of the punched hole. The width necessary to prevent a split from the hole to the edge of the plate is recorded.

STANDAND SHAPES OF TEST PIECES.

Figs. 2, 3, and 4 show standard shapes and dimensions recommended for test pieces. The specimens

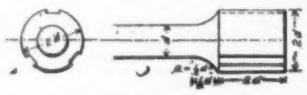


Fig. 4. Standard Shape for Torsion Tests.

to be held by true bearings on the end shoulders. When rough bars are to be tested, the standard gage length of 8 ins. is to be adhered to, and the gage marks should be distant from the holders not less than half the diameter of the piece.

For compression tests, cylinders 2 ins. in length and 1 in. in diameter are to be used when ultimate resistance alone is to be determined. For all other purposes specimens 1 in. in diameter and 10 and 20 ins. in length are to be used. The compression is to be measured on a length of 8 ins., as in tension tests.

Transverse tests are to be made on bars 1 in. square and 40 ins. long placed on supports 36 ins. apart, center to center. Where wood is to be tested the piece is to be 3 ins. square. Cast-iron bars should be cut out of a casting at least 2 ins. square or 2¼ ins. diameter; for routine tests, bars cast 1 in. square may be used.

Bending tests are to be made on flat strips 1 in. wide, or on round rods as they come from the rolls. The shape of piece for torsion tests is shown in Fig. 4.

Brief comment on the proposed code will be found on our editorial pages.

Other Rapid Transit Plans for New York.

Among the latest plans for rapid transit in this city, laid before the Commissioners, are the Gribble, Reno, Fosburg and Wegman-Bates projects. The scheme of Mr. T. G. GRIBBLE has been already briefly described. It is a combined surface and underground system, operated by electricity. The local traffic would be conducted on the surface and the express traffic beneath. He proposes to first lay down a floor of rolled beams of box form filled with concrete, and then to excavate beneath by ordinary tunneling methods. Side walls and center supports would finally carry the iron roof and the street surface. Sewers, gas and water pipes and electrical conduits are provided for in a central space, and under the express tracks.

Mr. JESSE W. RENO, of New York, proposes a four-track, double-deck, underground road under Broadway. He would steer clear of trouble with buried pipes by putting the roof of his tunnel 10 ft. below the present street surface. The outside width of his tunnel is 23 ft., thus avoiding interference with sidewalk vaults. His plan is to build the side walls one at a time by sinking a trench 3 ft. wide and 38 ft. deep, braced and supported by planking. This trench would then be filled with concrete to within 11 ft. of the surface and the rest of the trench filled in with earth. To excavate the ground between the walls thus built, he proposes to use a horizontal shield or roof provided with a steel cutting edge and pushed forward on the cement walls by hydraulic jacks. The roof proper would be laid under this and made of steel beams, which would be supported by systems of posts separating and carrying the double-decked roadway beneath. The estimated cost per mile is $941,000 below Union Square and $1,232,300 above that point, where rock is to be met with. The plan is not a bad one for a subway, though it is altogether probable that the workmen would be flooded out, or choked out now and then by a ruptured water or gas main during the construction.

Messrs. E. WEGMAN, Jr., and C. J. BATES propose an elevated system, which is practically a two-storied double-track structure of the present type. They would run through the blocks, and the plan shows wrought iron or steel posts carrying two deep cross girders supporting the two systems of tracks, one over the other.

Mr. KNUT FOSBURG, of Brooklyn, suggests a picturesque but generally odd design. It is a four-track subway, with the middle tracks above the side tracks, and a skylight through the center of the street is to furnish air and daylight, and also provides a surface resting-place for foot passengers.

TERMINAL FACILITIES FOR THE WORLD'S FAIR are to be provided by a company now being organized by Mr. E. T. JEFFERY, formerly of the Illinois Central R. R. A committee of railway men and engineers, including Messrs. M. GOTTLIEB, E. L. CORTHELL, THOMAS RODD and D. J. WHITTEMORE, was appointed some time ago, and figured for an elevated terminal costing $3,000,000. This did not please the railway men, and Messrs. THOMAS, JEFFERY and GOTTLIEB substituted a simpler plan, to cost $600,000. This is the basis of the company now being formed. The present plan involves a double-track surface loop with side tracks for car storage.

THE WORLD'S COLUMBIAN EXPOSITION seems likely to cost a pretty large sum before it is set in motion. Estimates of the amount proposed to be appropriated for the Fair by the Exposition Co., the United States, all the various states and territories and foreign nations, and by corporate bodies, trade associations and manufacturers show a total of $32,000,000. The labor unions are urging the Directory to insert in its contracts clauses favoring union labor, and it is likely that some concessions to them will have to be made, as every one will be anxious to avoid possible delay by strikes. Exposition buildings, with a total frontage of two miles, have been designed, and the plans have been approved by the Board of Control. A uniform height of 60 ft. for the front of the buildings is proposed, according to report.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Midland (Indiana).—There is talk of extending this railway from Brazil, Ind., via Middleburg, to Linton, Ind., a distance of 40 miles. The route is through a rich coal section.

Elmira, Cortland & Northern.—Tracklaying has been commenced on the terminals of the Camden, Watertown & Northern R. R., at Watertown, N. Y. The work is being done to secure the rights of way of the company in that city. No work except surveys has been done upon the remainder of the line, between Watertown and Camden.

New York, Lake Erie & Western.—This company will fill about 200 of its wooden bridges and change 50 or 60 from wood to iron during the present season. The work will all be done on the Chicago & Erie R. R., and will cost about $500,000.

New York Central & Hudson River.—This company has secured control of the Herkimer, Newport & Poland R. R., running from Herkimer to Poland, N. Y., 16.7 miles. The transaction also includes the franchises of the Mohawk Valley & Northern R. R. Co., chartered some time ago to build extensions of the former road. According to an interview with H. Walter Webb the New York Central will build extensions from Poland north to the Mohawk & St. Lawrence R. R., 28 miles, and from a point on the main line into the Adirondacks, 65 miles, and will also change the existing line to standard gage. Mr. Webb also stated that the Mohawk & St. Lawrence, the road which the New York Central is to construct to the Thousand Islands, would be from Rome to Carthage, and then make two branches, one to Clayton, on the St. Lawrence River, and the other to Watertown and Gouverneur. The line from Rome to Clayton would be 135 miles long and the one from Carthage to Gouverneur 30 miles long. Both the Mohawk & St. Lawrence and the Mohawk Valley & Northern lines would be completed by the coming fall. The engineer's estimate for the construction of the former line is between $10,500,000 and $12,000,000. The principal business of the lines will be the transportation of lumber and in the summer the passenger traffic to and from the Thousand Islands and other St. Lawrence River resorts.

Philadelphia & Reading.—Negotiations have been completed for the sale of the bonds secured on the property of the Terminal R. R. Co., and it is stated that construction will commence at once.

Wellsville, Coudersport & Pine Creek.—This railway, running from Wellsville to Geneseo, N. Y., will be changed to standard gage.

Monocacy Valley.—This company has made a proposition to the people of Middletown, Md., to extend its road from Catoctin Furnace to Yellow Springs, Md., on condition that they build a line from the last place to Middletown. It is thought that the proposition will be accepted.

Chicago & West Michigan.—The Chicago & North Michigan R. R. Co. has been chartered to build the proposed extension of this road from Traverse City to Charlevoix, Mich. The officers of the new company are: President, Charles M. Hensel; Vice-President, William A. Smith; Secretary, James Austin, and Treasurer, J. F. Howard. About $70,000 has been subscribed in aid of the enterprise, and it is announced that work will begin at once.

Deerfield River.—The township of Wilmington, Vt., has bonded itself for $32,000 in aid of the proposed extension of this road. The township of Whitingham has also voted $6,000, and will raise $4,000 more.

Projects and Surveys.

Jersey City Belt Line.—Chartered in New Jersey to build a line of railway about 6 miles long along the Morris Canal. The company is stated to be in the interest of the Lehigh Valley Co. Among the incorporators are: John Hood, Camden, N. J.; A. L. Voorhis, Newark, N. J., and Thos. W. Holme, Burlington, N. J.

Toledo, Ann Arbor & Mackinaw.—Chartered in Michigan to build a line of railway from Marion to Mackinaw, Mich. The officers are: President, I. A. Fancher; Vice-President, H. W. Ashley; Secretary, F. S. Chandler. The chief offices of the company are at Owasso, Mich.

New York, Bridgeport & Eastern.—This company has applied to the Connecticut Railroad Commissioners

for an approval of its layout. The company is an outgrowth of the old New York, Boston & Inland R. R. Co., projected to build a short-line railway between Boston and New York.

Emporium & Rich Valley.—Chartered in Pennsylvania to build a railway from Emporium, Pa., to the mouth of Elk River, in Shippen Co., a distance of 40 miles. C. B. Howard, Emporium, President.

Laurel & Roaring Point.—Chartered in Delaware to build a railway from Laurel to Chesapeake Bay.

Bath, Small Point & Popham.—Organized in Maine to build a railway from Bath Me., to Popham Beach. Among the incorporators are: Herbert G. Forbes, Waterville, Me., and Jos. H. Manley, Augusta, Me.

SOUTHERN.—Existing Roads.

Central R. R. of Georgia.—Tracklaying has commenced on the Mobile & Gerard R. R. from Troy, Ala., south, and several miles have been laid.

Roanoke & Southern.—About 1,700 men are now at work on the line between Roanoke and Martinsville, Va., 62 miles. The section from the North Carolina line to Martinsville will be completed in about two weeks. From Martinsville north 20 miles of the grading have been completed, and the contracts have been let for the remaining 42 miles, the work to be finished Aug. 19. Tracklaying will commence at Roanoke in about six weeks. Only 20 miles will be laid from this place south, the remainder being laid from Martinsville north. There will be three large bridges on the line. Bids are now being received for their construction.

South Bound.—The rails necessary to complete this road from the present end of track to Campbellton, S. C., are on hand, and it is expected to have the line completed from Campbellton to Savannah, Ga., by April 1, with the exception of the bridge at the Savannah River.

Lockhart & Catawba Falls.—The contracts for building this South Carolina railway have been let.

Macon & Atlantic.—About 3,000 men and 700 teams are now at work on this line between Pineora and Burton, Ga., and the 96 miles between these points are nearly graded, and track'aying is progressing at the rate of one mile per day. Twenty miles of track have already been laid, and it is expected that 20 miles more will be finished by March 15. Work has been commenced from Burton toward Macon. It is expected to have the entire line from Macon to Savannah, Ga., completed this year.

Way Cross Air Line.—About eight miles of the grading have been completed from St. Mary's toward Way Cross, Ga.

Rutledge & Julian.—About $1,500 of the two and three per cent. fund now in the Alabama State Treasury has been secured in aid of this road. The road is to run from Rutledge to Julian, Ala., about four miles, and is already partly graded.

Columbia, Newberry & Laurens.—This road is now about completed to a connection with the Georgia, Carolina & Northern R. R. at Clinton, S. C., 62 miles from Columbia.

Carolina, Cumberland Gap & Chicago.—It is stated that there is a possibility of work being resumed on this road, and the line completed from Edgefield to Abbeville, S. C., during the present season. The road was originally projected to run from Aikin, S. C., via Edgefield and Asheville, N. C., to Lexington, Ky., about 350 miles, and in 1888 the section from Aikin to Edgefield, 25, miles, was completed. Since that time no work has been done.

Georgia Southern & Florida.—Additional hands have been put at work on the branch from Tifton to Thomasville, Ga. The work is contracted to be finished by August.

Jacksonville, Tampa & Key West.—It is stated that this company will extend its line south along the Atlantic coast to Biscayne Bay, Fla. The company now operates a combined railway and steamship line to Lake Worth, and it is probable that the new line will start from the latter point.

East Tennessee, Virginia & Georgia.—An official of this road is reported as saying that a line from Rogersville, Tenn., north to Bay Sluice Gap, Va., will be built in the near future.

Georgia.—This company will erect a combined office building and passenger station at Augusta, Ga., at a cost of about $200,000.

Petersburg & Asylum.—This company, which now operates about 4½ miles of railway from the terminus of the Petersburg St. Ry. to the Central Insane Asylum and granite quarries, will extend its line about 4,000 ft. during the present season. The work will include the construction of an iron bridge 240 ft. long. President, Geo. Beadle, Petersburg, Va.

Savannah, Griffin & North Alabama.—This company will relay its roadbed with steel rails. The road runs from Sharpsburg to Griffin, 32 miles.

South Florida.—This company is building a 7-mile branch to Phosphate City.

Projects and Surveys.

Meridian, Brookhaven & Natchez.—This company has been organized with J. M. Turner, President, and J. W. McGath, Secretary. It has, it is stated, purchased 9 miles of track running from Brookhaven in the direction of Meridian from the Illinois Central R. R. Co.

Atlanta, East Lake & South River.—Chartered to build a railway from Atlanta, Ga., through De Kalb Co. to South River, 9 miles.

Orlando & Mosquito Inlet.—Chartered in Florida to build a railway from Orlando to Mosquito Inlet. J. G. Sinclair, Orlando, Fla.

Deep River & McLendon Valley.—A bill to incorporate a company by this name to build a railway from Gulf to Big Oak, N. C., has been introduced into the North Carolina Legislature.

Norwood & Rockingham.—A bill has been introduced in the North Carolina Legislature to charter a railway company by this name.

Elk River.—This company has been chartered in West Virginia. Principal office, Charleston, W. Va.

Fast Flying Tennessean.—A bill is before the Tennessee Legislature chartering a railroad by this name.

Wilmington & Southern.—A bill chartering a company to build a railroad from Wilmington, N. C., to Southport, N. C., is before the North Carolina Legislature.

Harriman Coal & Iron Co.—Contracts will be let about April 1 for this 14-mile railway at Harriman, Ky.

Montgomery, Hayneville & Camden.—Surveys have been completed for this railway from Montgomery, Ala., via Hayneville, Gordonville, Farmerville and Furman, to Camden, Ala., 73 miles. C. P. Rogers, Letohatchie, Ala., Chief Engineer.

West Virginia.—A railway to connect the Flat Top coal fields with the Chesapeake & Ohio R. R. is talked of by the operators of the coal mines in that section.

NORTHWEST.—Existing Roads.

Chicago & Northwestern.—It is reported that the Menominee Branch will be extended from the Mansfield mine to the town of Metropolitan, on the Felch Mountain Branch, 30 miles.

Minneapolis & St. Louis.—It is reported that the Cannon Valley line will be extended from Mankato, Minn., to Newton, Minn.

Milwaukee, Lake Shore & Western.—The bridge across the Wisconsin River at Wausau, Wis., on the Wausau-Marshfield Branch, is nearly completed, and work has commenced on the bridge over the slough. This latter will be completed in about three weeks, and work will then be pushed on the remainder of the branch.

Projects and Surveys.

Wisconsin.—It is stated that during the coming summer a railway will be built from Ellsworth to Mondova, Wis.

SOUTHWEST.—Existing Roads.

Little Rock & Memphis.—A correspondent writes us that the locating surveys for the Memphis, Little Rock & Pacific Ry. are in progress. The road is to run from Argenta, Ark., via Hot Springs, to the Indian Territory line, 150 miles. H. A. Schwanecke, Little Rock, Ark., Chief Engineer.

Atchison, Topeka & Santa Fe.—The report that this company will build a railway from Kansas City, Mo., to Memphis, Tenn., has been revived.

Chicago, Rock Island & Pacific.—It is announced that work will commence from Minco, Ind. Ter., south, within 30 days. Surveys have been in progress for some time.

Choctaw Coal & Ry. Co.—Additional hands will be put at work between Ft. Reno and Oklahoma, Ind. Ter. The surveys will soon begin for the extension west from Ft. Reno.

Projects and Surveys.

Wichita & El Paso.—The town of Wichita, Kan., has subscribed $30,000 in aid of this road.

Montgomery & Western.—Work is reported in progress on this road from Montgomery City, Mo., to quarries. Superintendent, L. Rossetter, St. Louis, Mo.

Fort Scott, Chanute & Western.—Chartered in Kansas to build a standard gage railway from Fort Scott to Guthrie, Ok., through the counties of Bourbon, Allen, Neosho, Wilson, Montgomery, Elk, Chautauqua and Cowley. The estimated length of the line is 300 miles. Directors, J. W. Davis, J. A. Bryant, J. D. Hill, C. F. Drake, W. W. Bell, W. H. Clark, J. D. McCleverty, all of Fort Scott. Capital stock, $2,000,000.

Fort Scott, Arkansas & Texas.—Chartered in Kansas to build a line of railway from Fort Scott, Kan., to Galveston, Tex., the same to pass through the counties of Bourbon, Crawford and Cherokee. Estimated length, 700 miles. Directors, C. W. Goodlander, W. M. Rice, J. L. Stewart, J. R. Collan, Morris Liebman, W. P. Perry and D. B. Berger, all of Fort Scott.

Fort Scott, Kansas City & Northern.—Chartered in Kansas with headquarters at Fort Scott for the purpose of building a standard gage railway from Kansas City, Mo., to Fort Smith, Ark., via Fort Scott, a distance of 400 miles, passing through the counties of Linn, Bourbon, Crawford and Cherokee, in the State of Kansas. The directors are: A. A. Harris, B. C. Garrison, John Crow, J. P. Chenault, A. W. Walburn, U. B. Pearsal and S. P. Mosher.

ROCKY MT. AND PACIFIC.—Existing Roads.

Port Townsend Southern.—Work is to be resumed on this Washington railway at an early date.

California.—A press dispatch says:

A contract for the construction of 45 miles of railroad, from San Quentin, Lower California, to Trinidad Pass, has been let by the Mexican Land & Improvement Co to R. A. Graham, and work will be commenced immediately. The work will commence July 1 on the road leading from Tia Juana south to connect with the former road at Ensenada.

Shasta Lumber Co.—Grading has been commenced on the 16-mile railway of this company from Anderson, Cal., to the company's flume. The road will be standard gage and laid with 53-lb. iron rails.

Great Northern.—Work on the Neihart and Barker branches of the Belt Mountain R. R. will commence early in the spring, the right of way having been secured from the claim owners for that purpose.

Northern Pacific.—Work is rapidly progressing on lines from Chehalis to South Bend, Wash., 56 miles. The graders have reached a point 9 miles from Chehalis west. From South Bend east 8 miles of roadbed have been graded, and 39 miles of the line still remains to be graded. Three and one half miles of track have been laid from the Chehalis Junction to the first crossing of the Chehalis River. There is a considerable amount of bridge building. The maximum grade is 1.6%.

Denver & Rio Grande.—Mr. J. Hale, of Chicago, Ill., informs us that this company will build a 12-mile branch to mines operated by the Magna Charta Mining Co.

Projects and Surveys

Continental Ry. & Telegraph Co.—A company by this name has been chartered in Colorado. The objects of the corporation are to build and maintain railway or telegraph lines from Denver, through Arapahoe, Jefferson, Boulder, Gilpin, Clear Creek, Grand, Eagle, Garfield, Routt, Rio Blanco and Mesa counties. The incorporators are: Edward P. Wells, James R. Hicks, Mason Wells and Mitchell Benedict, all of Denver. The capital stock is $200,000.

Anthracite.—Chartered in Colorado to build a railway to the coal mines near Aspen. Principal office, Delta, Colo.

San Joaquin Valley.—A press dispatch says:

A corps of surveyors has started to locate the route of the San Joaquin Valley R. R. The capital stock of the company will be $2,000,000. Rails have been ordered, and contracts have been entered into for the rolling stock to equip the road to the foothills. The total length of the road, with branches as planned, will be 100 miles or more.

FOREIGN.

Mexican Southern.—It is expected that the first division, from Puebla to Tecomavaca, will be opened for traffic about April 1. The line is already in operation from Puebla to Tehuacan, and about 31 miles of track have been laid from Tehuacan toward Tecomavaca. The total distance between these two places is 56.76 miles. There is a considerable amount of heavy work on this section, inclucing three tunnels 60 meters, 160 meters and 80 meters long, respectively. On the second division running from Tecomavaca to Oaxaca there will be a large amount of bridgework. Over 175 iron bridges will be built on this division.

CITY TRANSIT.

Electric Railways.—New lines or extensions of existing systems are reported as probable in the following places: Joplin, Mo., address the Joplin Electric Street Ry.; Salem, Ore., address the Capital City Ry.; Roseland, Ill., address the Calumet Electric Street Ry. of Chicago; Kansas City, Mo., address E. D. Brown; River Forest, Ill., address the Cicero & Proviso Electric Street Ry. of Chicago.

Lynn, Mass.—The Railroad Commission has granted permission to the Lynn & Boston R. R. Co. to issue $500,000 additional stock for the purpose of increasing its electrical equipment and for other necessary objects.

Washington, D. C.—The Edco Storage Battery System has been adopted by the Eckington and Soldiers' Home Ry. Co. This road was one of the first street railways to introduce electric traction and used the Thomson-Houston system very successfully for some years. The late action of Congress practically forbidding trolley poles in the heart of this city compelled them to make a change in methods. The Edco system is the invention of Mr. W. W. GRISCOM, President of the Electro-Dynamic Co., of Philadelphia, and is controlled by the Accumulator Co., of 44 Broadway, New York City.

Columbia, S. C.—The Columbia Street Ry. will be extended to several suburbs and be operated by electricity, it is reported.

Oxford, Ala.—The stockholders of the Oxford Lake Line will vote March 9 on an issue of $175,000 of bonds for an electric plant for the railway, which is now run by steam motors.

Memphis, Tenn.—The contract between the city and the owners of the street railway was signed Feb. 23, the proprietors depositing $100,000 of its bonds as a guarantee that electric cars will be running by April 1.

Chicago, Ill.—The Adams electric elevated railway, which there is some talk of using on the grounds of the Columbian Exposition, is similar in many respects to the Lartigue railway in use in Ireland. Only one rail is used, the cars being hung on this like saddles. The motor is in the middle of the car, which runs on two wheels and is prevented from tipping by side wheels running on guides attached to the girders below the main rail.

St. Paul, Minn.—Horses have at last been completely supplanted by electric motors in this city. A large number of extensions are contemplated by the St. Paul City Ry. Co.

Cheyenne, Wyo.—It is reported that the street railway will be changed to an electric line and extended to Fort Russell.

Seattle, Wash.—The Union Trunk Lines Co. will, it is said, begin work immediately on its lines to Lake Washington. The Rainier Ave. electric line, which runs through a part of the city but little built up, has begun to run 16 ft. box cars for light freight.

Horse Railways.—New lines or extensions are reported as probable in the following places: Eugene, Ore., address H. W. Helden, of Fort Wo th, Tex.; Charlotte, N. Y., address J. M. Allen, Charlottesville, Va.

New Orleans, La.—The Comptroller has been directed by the City Council to advertise for the sale by auction of the right of way for 25 years for street railway purposes over a large number of streets.

Cable Railway.—*Dallas, Ark.*—It is reported that a citizens' committee has raised $125,000 for building a cable road.

New Companies.—Harding Electric Railway Co., Atlantic, Ia.; capital stock, $1,000,000; incorporators, C. K. Harding, J. B. Jones, A. W. Dickerson. Joplin & Grand Falls Electric Ry. Co., Joplin, Mo.; capital stock, $100,000. Norristown Traction Co., Norristown, Pa.; capital stock, $100,000. Waco, Tex., Electric Ry. & Light Co.; capital stock, $250,000; incorporators, W. J. Hobson, B. Moore, J. Sleeper and others. Washington & Arlington Ry. Co., Washington, D. C. Benson & Halcyon Heights Street Ry. Co., Omaha, Neb.; capital stock, $25,000; incorporators, A. and H. H. Benson, W. H. Crary and others. Metropolitan Ry. Co., San Francisco, Cal.; capital stock, $1,000,000; directors, C. E. Mayne, H. A. Iddings, N. Crocker, G. J. Bailey, A. S. Culver and others; object, construction of a cable railway. Queen City Electric Street Ry., Marion, Ind.; capital stock, $150,000; incorporators, G. L. Mason, W. H. Wiley, W. H. Farnum. Southern Suspended Cable Car Co., Atlanta, Ga.; capital stock, $300,000; incorporators, A. L. Beck, J. V. Heidt, C. P. Turner, G. Hope.

HIGHWAYS.

New York.—The State Roads Improvement Association has passed resolutions indorsing the Weller and Richardson road bills. The Association is to be incorporated.

New Jersey.—The Kearny Township Committee has awarded the contract for macadamizing Kearny Ave. to E. H. Harrison & Son, at $10,000.

Maryland.—The Eastern Ave. Turnpike Co. has presented to the County Commissioners, at Towson, a petition for permission to construct a turnpike road on Eastern Ave. extended from the eastern limits of the city to Back River, or as much of the avenue as may be under the control of the commissioners. The county would have the free use of a level, solid roadbed instead of the uneven, muddy roadbed which now exists, the company being willing that the county should have free use for its police force and fire department, or any convey ances of a public character. A meeting of the farmers of Harford Co. was held recently at Belair, and was addressed by Prof. Haupt. A resolution was adopted to appoint a committee to report at the next meeting a bill to be presented to the legislature empowering the Governor to appoint a civil engineer for the state, who shall receive a reasonable compensation for his services, and for the services of his appointees, from an appropriation from the state treasury; the engineer to appoint a staff of engineers, consisting of one from each county, who shall be stationed in the county towns and devote their entire time to the improvement of the county highways. The committee is also to see that the duties of the county commissioners are amended so as to place the roads, when petitioned for, under the entire control of the state engineer, and to place at his disposal the usual appropriations for such roads. The following were appointed on the committee: William L. Amoss, A. P. Silver, John Moores, George R. Stephenson and W. Beatty Harlan.

Tennessee.—Roane Co. and Jefferson Co. propose to issue bonds for $150,000 and $100,000 respectively, for road improvements and bridges.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Bridgeport, Conn.*—Bids have been received from the Berlin Bridge Co., the Groton Bridge Co., the Pittsburg Bridge Co., the Smith Bridge Co., the Wrought Iron Bridge Co., the Vermont Construction Co., the Boston Bridge Works, the King Bridge Co., the Pennsylvania Bridge Co., and Dean & Westbrook, for the bridge across the Housatonic River at Birmingham, Conn. The bridge is of iron, 200 ft. long, 27 ft. roadway, and two 5 ft. sidewalks. All bids were under $65,000, the amount appropriated. Over 60 different bids were submitted by the above-named companies. Contracts are to be let March 7.

Cuttingsville, Vt.—An iron truss bridge will be built at this place.

Washington, D. C.—Bills have passed the House authorizing the construction of bridges at Lexington, Mo., and Van Buren, Ark.

Glasgow, Va.—The Chesapeake & Ohio R. R. Co. proposes, it is stated, constructing a bridge across North River, and making Glasgow the junction for its Lexington branch, instead of Balcony Falls.

Guyandotte, W. Va.—The Ohio River R. R. Co. has, it is stated, decided to construct a bridge across the Guyandotte River and extend its railroad from Guyandotte to the new town of Kenova, a distance of 11 miles.

WATER-WORKS.

NEW ENGLAND.

Auburn, Me.—A bill authorizing the purchase by the city of the works of the Auburn Aqueduct Co. is before the legislature.

Exeter, N. H.—The Exeter Water Co. has been granted legislative permission to extend its mains through the towns of Stratham and South Newmarket.

Salem & Methuen, N. H.—The Salem Water-Works Co. has secured a charter. It is thought that the supply for Salem will be from Policy Pond. It is reported that Methuen will also be supplied.

Hardwick, Vt.—A committee has been appointed to ascertain the cost of works.

Middlebury, Vt.—Four per cent. water bonds to the amount of $30,000 are offered for sale. The village has an assessed valuation of $1,300,000, and but $20,000 of debt.

Lawrence, Mass.—Superintendent A. H. Salisbury has been authorized to investigate methods of filtration.

Lowell, Mass.—C. L. Trapp, clerk of Water Board, informs us that they will soon advertise for bids for 750 tons of 30-in. 250-lb. cast-iron pipe, and later for heavier pipe; also that the contract for the 10,000,000-gall. pumping engine has been awarded to H. R. Worthington, New York. A press dispatch states that the contract price is $37,500,000 galls.

Melrose, Mass.—Filtration of Spot Pond water, which supplies Melrose, Malden and Medford, is being discussed.

Millbury, Mass.—A resident informs us that a charter for a water company has been applied for, but nothing further has been done.

Milford and Hopedale, Mass.—The company has offered to build a 500,000-gall. reservoir if the hydrants are increased from 93 to 125.

Waltham, Mass.—An order for an appropriation of $20,000 for water-works has passed a second reading.

Providence, R. I.—Water mains have been ordered laid in three streets.

Woonsocket, R. I.—A new 5,000,000-gall. pumping engine, a boiler, force main and 1,000,000-gall. tank have been recommended by the commissioners.

South Norwalk, Conn.—Bids are wanted by the water commissioners until Mar. 10 for laying 22,000 ft. of 16 and 3,420 ft. of 12, 10 and 4-in. mains.

Westport, Conn.—A contract has been made with the Westport Water Co. for 50 hydrants at a yearly rental of $30 each.

MIDDLE.

Babylon, N. Y.—An engineer has proposed to make a survey for works to supply Amityville, Breslau and Babylon.

East Aurora, N. Y.—The works have been tested.

Holland, N. Y.—It is reported that the construction of works will soon be started. The Holland Water-Works Co. was incorporated last January with a capital of $10,000.

Port Jervis, N. Y.—E. H. Ellis, Superintendent, informs us that they propose to enlarge the mains in the business part of the village.

Rochester, N. Y.—The following is from Emil Kuichling, Chief Engineer, under date of Feb. 27:

A bill authorizing the city to issue $1,750,000 of bonds is before the legislature. It is believed that this sum is sufficient to build a new conduit without additional reservoirs, for a gravity supply from either Hemlock or Conesus Lake, or a pumping supply from Lake Ontario, in any case the ultimate daily delivery to be 15,000,000 galls. No official decision as to source has been made, but it is believed that the majority of the citizens who have given the subject thought advocate one of the gravity sources.

Jersey City, N. J.—The National Water Supply Co., Cincinnati, O., has made a proposition to examine and report on a new supply, either from driven wells or lakes.

Plainfield, N. J.—It is reported that the Plainfield Water Supply Co., which was incorporated nearly 22 years ago, has bought the 20 driven wells and the partially constructed pumping station of the company engaged in building works, and that the former company will be ready to supply water by July 1.

Rutherford, N. J.—C. E. Tolhurst, Borough Clerk, has sent the following:

Various methods of obtaining a supply have been proposed, and it is probable that contracts will be let in the near future, but nothing definite has been decided. Population of borough, about 2,500.

Homestead, Pa.—A motion to build works is before the Council.

Wilkesbarre, Pa.—The Honey Brook Water Co. has been incorporated; capital, $10,000.

SOUTHERN.

Bentonville, Va.—It is reported that works are to be built by the Bentonville Mining & Improvement Co.

Carnegie City, Va.—The following is from the Elliston Machine Co.:

The Elliston Land Co. proposes to build works soon at a cost of about $5,000, taking their supply from a spring 1¼ miles from and 190 ft. above the village. G. G. Junkin is President of the company and D. W. Batchelder is Engineer. The name of the place will soon be changed to Elliston. Population, 300 to 400.

Danville, Va.—Regarding the reported work on a reservoir, C. A. Ballou, City Engineer, has sent the following:

The new reservoir has never been completed. The embankments must yet be raised 5 ft., the outer slope turfed and the drive on top graveled. As yet the Council has taken no action on the recommendation that the work be done during the coming season.

Radford, Va.—The Council has decided to contract with the Radford Land & Improvement Co. for a water supply, the town, evidently, building the distribution.

Roanoke, Va.—It is reported that not less than 20,000 ft. of new mains will be laid during this year.

Bridgeport, W. Va.—Address the Mayor regarding works.

Grafton, W. Va.—J. B. Strawn, Salem, O., has been engaged by the Council to prepare plans and estimates for works, including a supply to be pumped from Tygart Valley River to a reservoir.

Fayetteville, N. C.—The following is from J. D. McNeil, Chairman of Water works Committee.

The Council has passed an ordinance guaranteeing 1-10 of the town property tax as a fund for the payment of water for public use. The Council wishes to grant a fair franchise to a company. The topography is especially suitable for water-works.

Raleigh, N. C.—A. Thompson, Mayor, informs us that the city is considering the purchase of the company's works, but the matter has not yet taken definite shape.

Blacksburg, S. C.—Works are projected.

Darlington, S. C.—The Darlington Light, Water & Power Co. has organized, with C. S. McCullough President and G. M. Boyd Secretary.

Athens, Ga.—It is reported that there is a move for the purchase of the company's works by the city.

Fort Valley, Ga.—H. C. Harris is President of the commissioners in charge of the erection of works.

Macon, Ga.—The Jeter & Boardman Water & Gas Association of Macon has purchased the works of the Macon Gas Light & Water Co., and will enlarge them at an estimated expense of $200,000. A reservoir 200 ft. in diameter and 16 ft. in depth will be built to receive the water from the Tuft Springs.

Columbia, Ala.—The issuance of water-works and electric light bonds is under consideration.

Piedmont, Ala.—The following is from T. S. Farquharson, City Engineer and Engineer of the Piedmont Land & Improvement Co.:

Correspondence regarding the introduction of water-works is desired. Address C. W. McMahon. The population is about 1,200, with several large industries requiring a large amount of water. A $25,000 Edison electric lighting plant has been introduced.

Troy, Ala.—Water bonds to the amount of $50,000 have been authorized.

Johnson City, Tenn.—The company has signed the bonds guaranteeing the execution of the contract, and the works will be speedily completed.

Knoxville, Tenn.—The following is from C. F. Wood, Engineer and Superintendent:

The Knoxville Water Co. has received the North Knoxville water contract, and will make one with West Knoxville Friday, March 6. Eight to 10 miles of pipe will be laid and a high service system built in connection with the present works.

Nashville, Tenn.—George Reyer, Superintendent, informs us that a new pumping engine will probably be added next fall. It will be a 10,000,000-gall. Worthington, working against a 360-ft. head.

Union City, Tenn.—Price Thomas is the Manager of the Union City Water Co., recently organized.

NORTH CENTRAL.

Cincinnati, O.—Another storage tank on Price Hill is under consideration. A bill has been introduced in the State Senate providing for the issuance of bonds and the amount of $500,000 for new works to be built under the direction of a commission to be appointed by the Mayor.

Columbus, O.—Pipe is to be furnished the city during the coming year by the Lake Shore Foundry Co., Cleveland, at $23.45 per ton, and special castings by the same company for 2½ cents per pound. The estimates of expenditures for 1891 include $150,000 for furnishing and laying distributing mains and $99,900 for 11,000 ft. of 36-in. mains. A later item in the *Leader* states that there is some doubt whether the pipe contract was legal, owing to lack of funds, but it seems probable that funds will be provided in some manner.

Bloomington, Ind.—By a vote of 4 to 1 the people have decided in favor of water-works. It is stated that the contract has been closed and that construction will be started at once.

Portland, Ind.—A water-works election will be held March 17.

Blooming Prairie, Mich.—Water-works bonds are to be issued.

Lincoln, Ill.—A press dispatch states that the city has refused to pay hydrant rental, on the ground that the contract with the company has been annulled by non

fulfilment; that the company has shut off the hydrants, and that new works will be built.

Norwood Park, Ill.—H. A. Donaldson, Village Clerk, will receive bids until March 9 of distributing mains; size and length not stated.

Antigo, Wis.—The works of the Antigo Water Co. have been tested.

Waupaca, Wis.—It is reported that a water company is now being formed.

NORTHWESTERN.

Adrian, Minn.—Bonds for works are to be issued.

Northfield, Minn.—A move for water-works is on foot.

Winthrop, Minn.—Bonds have been authorized for water-works and electric lights.

Abilene, Kan.—Improvements have been completed by the company at a cost of $56,000. Water is now pumped from springs four miles west of the city.

Beloit, Kan.—Bids for piping for the fire protection of the Industrial School for Girls will be received until March 20. Address L. L. Kirk, President, Copeland House, Topeka.

Lindon, Kan.—The Lindon Water Co. has been incorporated; capital, $10,000; directors, Nick Frankhouser, C. A. Bailey and others.

Marion, Kan.—The Marion City Water, Land, Electric & Power Co. has been incorporated; capital, $100,000.

Holdrege, Neb.—The works of the company have been purchased by the city at a sale, under an order from the U. S. Court; price, $36,000.

Nemaha City, Neb.—Small works are being discussed.

Omaha, Neb.—President Underwood is reported as having said that a new 24-in. main will be laid to South Omaha this year.

Ponca, Neb.—Construction will probably be started soon.

Rawlins, Wyo.—The following is from N. Rasmusson, Mayor:

An election is to be held April 15 to decide whether the city shall be bonded for $35,000 for water-works. If the bonds are voted, the city proposes to put down two artesian wells, lay mains and place 54 hydrants. The Union Pacific Ry. Co. is now supplying the city temporarily from artesian wells with a combined daily capacity of from 500,000 to 600,000 galls.

SOUTHWESTERN.

Kirkwood, Mo.—The Sunset Hill Water, Power & Light Co. has applied for a franchise. The company has an authorized capital of $100,000, of which Secretary Laderer states that $40,000 has been subscribed, including $15,000 subscribed by residents.

Cisco, Tex.—J. H. Holcomb, Manager Cisco Water-Works Co., informs us that the contract for improvements has been let to Z. T. Williams, who represents the Alabama Pipe Works. A press dispatch states that the work will be done under the direction of J. S Thacher, Engineer, at a cost of $25,000, including a storage reservoir, main, and stand-pipe.

Denton, Tex.—The Denton Water, Light & Power Co. has been organized; capital, $50,000.

Morgan, Tex.—J. E. Moss wants bids for 150 tons of 12-in. cast-iron pipe, ¾ ins. thick.

Temple, Tex.—It is reported that the stand-pipe which recently gave way will be rebuilt at an estimated cost of $15,000, after plans by Weir, Hartford & Mitchell, Chattanooga, Tenn.

South Denver, Colo.—The Town Trustees have passed an ordinance to be submitted for popular ratification, providing for the issuance of 6% 10 to 15-year water bonds to the amount of $100,000. Twenty miles of mains are contemplated. The water committee were prepared to assume charge of the works March 1.

PACIFIC.

Dayton, Wash.—The question of issuing bonds to the amount of $75,000 was voted on March 2.

Tacoma, Wash.—The following is from the Tacoma Light and Water Co.:

A new 36-in. supply main will be laid immediately to American Lake, 9 miles distant; two 1,500,000-gall. pumps will be added to the city pumping station, and two 3,000,000-gall. pumps will be placed at American Lake. These improvements are for a temporary supply and in the meantime the construction of a permanent system will be carried on, it being proposed to bring water from Green River, 30 miles distant. This supply will be by gravity and will give a high pressure in the city.

Dalles City, Ore.—Water bonds to the amount of $50,000 are to be issued.

Pomona, Cal.—It is reported that 50 hydrants will be added.

CANADA.

Montreal, P. Q.—An appropriation of $60,000 for pipe extension has been asked by the water department.

Toronto, Ont.—The water-works committee has voted in favor of buying a new 10,000,000-gall. pumping engine to replace the old 4,000,000-gall. pump at the main station. Money to pay for the proposed pump has not been voted by the people, and several appropriations have recently been voted down.

ARTESIAN WELLS.

Mason City, Ia.—A contract has been let for a well 600 ft. deep.

Aberdeen and Huron, S. Dak.—Sterrit & Adams, Keokuk, Ia., have contracted to sink ten wells for the Dakota Irrigation Co., of which S. W. Narregang is President. Most of the wells will be sunk in the James River Valley.

Clark, S. Dak.—The town has contracted for a well 1,500 ft. deep, or less if a flow is struck nearer the surface.

Parkston, S. Dak.—The Scotland Artesian Well Co. has the contract for a 4-in. well for the town.

Denison, Tex.—It is reported that the Denison City Water Co. will sink a well.

IRRIGATION.

Candler, Fla.—An irrigation plant is being put in by J. I. Matthievson for his orange grove.

Hamilton Co., Kan.—The Kendall Canal Co. has been incorporated; capital, $1,000; directors, J. M. Johnson, G. Hill and F. M. Kelley.

Culbertson, Neb.—The French Valley Irrigation & Water Power Co. has been incorporated; capital, $50 000.

Montrose, Cal.—The Ft. Crawford Ditch Co. has been incorporated; capital, $2,500.

Pasadena, Cal.—An irrigation district may be formed and storage reservoirs and canals constructed.

Temecula Valley, Cal.—A survey has been completed by the Temecula Valley Land & Water Co., of San Diego, for a reservoir with dam reported as projected with a height of 260 ft. C. F. Smith is Manager. The project is said to include water enough for 45,000 acres.

Whittier, Cal.—The East Whittier Land & Water Co. is laying a concrete conduit 27,000 ft. long from Puente Creek crossing to Whittier. A. L. Reed, of Whittier, is general manager.

SEWERAGE AND MUNICIPAL.

Sewers.—*Newton, Mass.*—A plan for sewer assessment has been proposed by Mr. J. T. Langford. It provides for an assessment of 30 cts. per ft. of frontage, 35 cts. per sq. ft. of area extending back 180 ft., and places an additional tax upon land according to its value; also providing for an assessment of $25 for entering the sewer. By this plan the city assumes a proportion of the cost of the system, aside from that of the cost of maintenance of the main sewer, provided for in the plan adopted by the City Council.

Orange, N. J.—The Sewerage Committee has submitted its proposed ordinance to the Council.

Newark, N. J.—It is proposed to appoint a board of engineers to investigate the question of the benefits of the intercepting sewer, to settle the disputed assessment of cost.

Clarion, Pa.—A sewerage system is under consideration. About three miles of sewers have been laid.

Wilmington, Del.—Mr. T. C. Hatton, Engineer in charge of sewers, has made a partial report and plan. All sanitary sewage to be discharged into the Delaware River, and storm water into Christiana River and Brandywine Creek. The recommendations of the report have been accepted by the Street and Sewer Department. Bonds are to be issued for $30,000.

Lynchburg, Va.—The city will issue bonds for $10,000 for sewers and $30,000 for street work.

Wilmington, N. C.—A bill has been passed authorizing the construction of a system of sewerage. Bonds will be issued for $100,000 for sewerage and $100,000 for streets.

Asheville, N. C.—It is proposed to spend $100,000 for sewers and $500,000 for streets.

Columbia, S. C.—A proposition to establish sewers, made by a company, has been referred to the Committee on Sewerage.

New Decatur, Ala.—The city has applied to the legislature for power to construct a system of sewers.

Anniston, Ala.—The sewers will be extended about four or five miles.

Columbus, O.—An ordinance has been introduced providing for the sewerage and drainage of all territory of the city south and west of the Scioto River. The Board of Public Works is directed to have a plan of sewerage and drainage devised. The city has been given authority by act of the legislature to issue $250,000 bonds for the construction of sewers on the West Side. The city engineer has prepared a plan of sewerage which he estimates will cost $300,000. It provides a separate system to be connected with the intercepting sewer and another system to carry off the rainfall.

Kensington, Ill.—The Sewer Committee has approved the ordinance and plans for the proposed drainage district prepared by Mr. Cheney, the Engineer.

St. Paul, Minn.—In 1890 20.7 miles of sewers were built, and about 10 miles are to be built this year. Two large contracts are now under way. The contracts to be let this year will be all for small lateral pipe sewers. Mr. Geo. L. Wilson is the Engineer in charge.

Carson City, Nev.—The City Trustees have in contemplation the construction of a complete system of sewers at an early date. W. H. Doane is City Clerk.

Albany, Ore.—The city has been authorized to issue bonds for $75,000 for sewers and public improvements.

Streets.—*Holyoke, Mass.*—The Highway Committee has proposed to use hard burned brick in place of granite blocks, but there is a strong opposition to the change.

Baltimore, Md.—Asphalt paving is proposed for Broadway by the East Baltimore Improvement Association.

Louisville, Ky.—The Council has been petitioned to pave Baxter Ave. with granite.

Athens, Ga.—It is proposed to issue $75,000 in bonds for paving purposes.

Madison, N. C.—It is proposed to issue bonds for street paving.

Greenville, S. C.—A bill is before the legislature to authorize the issue of bonds for street improvement.

Montgomery, Ala.—Gravel is being proposed as a good material for paving the streets. It is said to have been used with success at Selma.

Oxanna, Ala.—Bonds for $5,000 for street improvement have been authorized.

Lagrange, Ill.—The Village Council proposes to lay cedar block paving on Fifth Ave.

Kansas City, Mo.—For street paving the Board of Public Works has designated asphalt, vitrified brick and granite blocks on concrete, or sandstone or granite blocks on sand.

Salt Lake City, Utah.—A paving company is being organized by Timothy Hopkins and others who are interested in the California asphalt deposits. Capital stock, $5,000,000.

Street Signs.—*Buffalo, N. Y.*—The Lamp Committee has been examining various styles of signs, and has adopted the Hewitt blue enameled sign on the recommendation of the City Engineer. About $17,000 will be spent on signs.

Lighting.—*Louisville, Ky.*—The Mayor and Council are desirous of obtaining better gasoline lights. The Mayor has been authorized to advertise for proposals for the purchase of the plant and for furnishing the city with gasoline lamps. The Sun Vapor Street Lighting Co. has made a proposition.

ELECTRICAL.

Electric Light.—New plants or enlargements of existing stations are reported as probable in the following cities: Thompsonville, Conn; Newark, O., address the Mayor; Columbia, S. C., address Maj. G. B. Edwards of Charleston, S. C.; Troy, Ala., address the Mayor; St. Clairsville, O.; Versailles, Ky; Nashville, Tenn., address the Capitol Electric Co.; Shelbyville, Tenn.; Ennis, Tex., address J. S. Thatcher; Raleigh, N. C.; Columbus, Ga., address the Brush Electric Light & Power Co.; Royersford, Pa., address S. H. Egolf; Martinsville, Ind.; Athens, Ga., address R. L. Bloomfield; Vineland, N. J., address H. S. Foster; Roanoke, Va., address G. L. Colgate; Pueblo, Colo., address J. F. Vail; Salem, Va., address the Salem Electric Co.; New Lewisville, Ark., address the Red River Lumber Co.; Olathe, Kan., address S. F. Howe; Vicksburg, Tenn., address the Hill City Electric Light Co.; Mascoutah, Ill., address the Mayor; Cedar Rapids, Ia., address the Cedar Rapids Electric Light & Power Co.; Winnebago City, Minn.; Harlan, Ia., address J. L. Mills; Bellevue, O., address J. H. Weber.

Windsor Locks, Conn.—The Windsor Locks Electric Light Co. has issued the following list of prices: For 16-c. p. lamps, $1 per year for mills and churches, $1.50 per year for dwellings, 50 cts. a month for stables and stores, 60 cts. a month for saloons, hotels and apothecary storgs.

New York, N. Y.—The Board of Electrical Control has required all the wires in a large district in the centre of the city to be placed under ground by June 1.

Gloversville, N. Y.—The following bids for lighting the City Hall were recently received: The Gloversville Electric Co. offered to furnish current at 19 cts. per 1,000 watts, wiring to be done at the city's expense; the Johnstown Electric Light & Power Co. offered 16 c. p. lamps burning until 1 A. M., at $7.50 per lamp year, the city paying for wiring.

Allegheny, Pa.—The Allegheny County Light Co. will, it is reported, remodel its present plant into a station capable of running 135,000 lamps of 16 c. p. each.

Baltimore, Md.—The recommendation by the Mayor for the city to buy a municipal lighting plant has been taken up by a special committee, which reports that the following cities furnish their own lights, in whole or in part: Huntington, Pa., 50 lights at $48.64 a year each; Bay City, Mich., 134 at $60; Lewiston, Me., 96 at $42; Chicago, Ill., 297 at $80; Dunkirk, N. Y., 55 at $36.50.

Parkersburg, Va.—The Thomson-Houston Co. has offered to supply the city with 100 lights for five years at $6,200 a year.

Richmond, Va.—Col. Cutshaw, City Engineer, has submitted to the Council his estimate of the cost of a municipal electric station capable of furnishing 400 arc lights of 200 c. p. and 1,500 incandescent lamps of 16 c. p. The buildings are to be of sufficient size to accommodate a plant of 800 arc and 7,000 incandescent lamps capacity. The cost of the station is estimated as follows: Buildings, $13,135; brick stack, $3,889; foundations for machinery, $4,150; engines, boilers and appurtenances, $34,125; water and drain pipes, $448; shafting, pulleys and belting, $3,960; electric machinery and appurtenances, $23,797; lamps, poles and wiring, $55,448; total, $138,912.

Wheeling, W. Va.—J. A. Seeley, of New York, has prepared the following estimate of the cost of a municipal plant of 400 arc lights capacity: Building, $8,000; foundations for machinery, $2,000; engines and boilers, $16,000;

shafting and pulleys, $4,000; electrical machinery, appurtenances and wire, $59,600; total, 89,600.

Charlotte, N. C.—There is some talk of a public vote being taken on the advisability of issuing $200,000 of bonds for an electric-light plant and water-works.

Elkin, N. C.—T. J. Lillard wants prices on dynamos and accessories for a 15-arc and 200-incandescent light plant.

Lexington, Ky.—The City Council has recommended that a 5-year contract be made with the Central Electric Light Co. for 200 or more 20-c. p. incandescent electric lamps, at $20 per lamp year.

Lancaster, O.—The City Council has contracted with the Lancaster Electric Light Co. for 76 all-night street lights at $90 each per year.

De Pere, Wis.—J. Hoberg, of Kaukauna, has offered to furnish private consumers here with 16-c. p. lamps at 4 mills an hour, and the city with 16, 24 and 32 c. p. lamps at $7, $9 and $12 a year, respectively.

Fort Dodge, Ia.—At the coming city election a vote will be taken on the desirability of purchasing and operating a municipal electric station.

Kirkwood, Mo.—It is reported that residents in this city have subscribed $15,000 to the Sunset Hill Electric Light, Water & Power Co., which will, it is said, begin work on its plant by April 1.

Sulphur Springs, Tex.—Proposals for supplying the city with water works, sewers and electric-light plant will be received by Mayor W. F. Henderson until April 1.

New Companies.—Fulton Electric Light & Power Co., Fulton, N. Y.; capital stock, $80,000. Citizens' Electric Co., Pueblo, Colo.; capital stock, $100,000; incorporators, J. F. Vail, C. H. Lamkin, F. H. Devine. Western Electrical Supply Co., Chicago, Ill.; capital stock, $30,000; incorporators, W. Alton, Jr., W. H. and J. McKinlock. La Grange, Ky., Electric Light & Power Co.; capital stock, $15,000; D. C. McDowell, secretary. Jellico, Tenn., Ice & Electric Light Co.; incorporators, A. Bindewald, W. Meyer, J. L. Reed. Union Electric Mfg. Co., Bridgeport, Conn.; incorporators, J. M. Orford, J. English, H. T. Clark. Mount Sterling, Ill., Light & Power Co.; capital stock, $10,900; incorporators, F. W. Rottger, A. Bailey, E. Schonen. Charleston, Ill., Thomson-Houston Electric Co.; capital stock, $40,000; incorporators, J. C. and F. A. Brooks, A. M. Searles. Standard Electric Co., Chicago, Ill.; capital stock, $100,000; incorporators, W. A. Conover, F. E. Charnley, F. M. Clocke. Lorain County Light & Power Co., Elyria, O.; capital stock, $50,000. Commercial Electric Light & Power Co., Tacoma, Wash.; capital stock, $250,000; W. B. Bushnell, president; L. G. Bigelow, secretary. Monterey, Cal., Electric Light & Development Co; capital stock, $250,000; directors, E. Ingram, S. H. Smith, D. R. Dodwick, E. M. Carver, F. R. Day.

CONTRACTING.

Dams and Shore Protection.—The following proposals have been received by Major A. Mackenzie, U. S. Engineer Office, Rock Island, Ill., for constructing and repairing dams and shore protections of brush and rock. The prices are for materials in place.

Between Reed's Landing and Minneiska, Minn.	Rock. Cu. yds 25,000	Brush. Cu. yds 20,000.	Total.
	$	$	$
J. Richtman, Fountain City, Wis.	1.20	.27	38,400
A. Kirchner, " "	1.17	.50	39,250
A. Delaney, St. Paul, Minn.	1.15	.60	40,750
W. A. and S. T. Patterson, Keokuk, Ia.	1.35	.48	43,350
A. J. Whitney, Rock Island, Ill.	1.30	.65	45,500
N. Martin and T. Mitchell, Hastings, Minn.	1.35	.60	45,750
Between Bellevue, Ia., and Savanna, Ill.	13,000	10,000	
W. A. and S. T. Patterson	.90	.38	15,500
A. Kirchner, Fountain City, Wis.	1.09	.39	18,070
J. Richtman, " "	1.20	.27	18,300
S. J. Truax and G. J. Hetherington, Hastings, Minn.	1.14	.40	18,820
A. J. Whitney, Rock Island, Ill.	1.00	.60	19,000
J. and J. H. Coleman, Davenport, Ia.	1.25	.45	20,750
A. Delaney, St. Paul, Minn.	1.28	.64	23,040
N. Martin and T. Mitchell	1.40	.60	24,200
Near Prairie du Chien, Wis.	14,000	14,000	
W. A. and S. T. Patterson	.90	.40	18,200
Truax and Hetherington	.89	.41	18,620
J. Richtman, Fountain City, Wis.	.90	.50	19,600
A. Kirchner, " "	1.09	.39	20,720
A. J. Whitney, Rock Island, Ill.	1.00	.60	22,400
J. and J. H. Coleman	1.25	.45	23,800
A. Delaney, St. Paul, Minn.	1.18	.62	24,920
N. Martin and T. Mitchell	1.35	.60	27,300

Water Pipe.—*Cleveland, O.*—The following proposals have been received by the Water Board: Lake Shore Foundry, Cleveland; $23.45 per ton for pipe, 2½ cts. per lb. for special castings. Addyston Pipe & Steel Co., Cincinnati; $27 and 3¾ cts. Ohio Pipe Co., Columbus; $28 and 3⅝ cts. The contract was awarded to the Lake Shore Foundry.

Brick, Cement, Etc.—*Washington, D. C.*—Contracts have been awarded as follows for materials for the Congressional Library: Washington Brick Machine Co., $7.75 per 1,000 for best red hard burned brick. J. Z. & J. N. Waters, Washington; natural hydraulic cement, $1.25 per bbl. in barrels, or $1.05 per bbl. in bags. James T. Summers, Washington; coarse and fine sand, 98 cts. per cu. yd. Wm. Wall's Sons, New York; manila rope, 12 cts. per lb.

Court House.—*Plattsmouth, Neb.*—The contract for the Cass County Court House has been awarded to O. J. King, of Omaha, at $67,910. It will be a brick and stone structure 80 × 102 ft., and 46 ft. high, with a clock tower 96 ft. high.

Dredging.—*Philadelphia, Pa.*—The Board of Port Wardens has awarded the contract for dredging the docks into which sewers discharge, to the American Dredging Co. at 16 cts. per cu. yd.

Filling.—*New York, N. Y.*—The contract for filling in behind crib bulkheads on the Harlem River has been awarded by the Department of Docks to M. H. Whalen & Co. at 14 cts. per cu. yd.

Castings.—*Boston, Mass.*—The Water Department has awarded the contract for 500,000 lbs. of iron castings and 150,000 lbs. of service box castings to Osgood & Hart at 2 cts. per lb; also for 10,000 lbs. of composition No. 1 brass castings, 20,000 lbs. of No. 2 and 12,000 lbs. of No. 3 to Wm. Curley, at 18½, 18½ and 15 cts. per lb.

PROPOSALS OPEN.

Levees.—About 655,000 cu. yds. on three levees. Board of Commissioners for Fifth Louisiana Levee District, Delta, La. March 10.

Raising, enlarging and construction on about 127 miles of levees. Board of Commissioners of the Atchafalaya Basin Levee District, Port Allen, La. March 11.

Water-Works.—*Beloit, Kan.*—Water piping and piping for fire protection at industrial school for girls. Architect, Geo. P. Washburn, Ottawa, Kan. Board of Trustees, State Charitable Institutions, Topeka, Kan. March 20.

South Norwalk, Conn.—About 22,000 ft. of 16-in. pipe, 1,560 ft. of 12 in., 1,160 ft. of 10-in., 200 ft. of 4-in. Board of Water Commissioners. March 10.

Sulphur Springs, Tex.—Water-works, sewerage and electric light. W. F. Henderson, Mayor. April 1.

Bridges.—One iron bridge, 100 ft. span, on stone piers; 1 arch culvert. F. J. O'Flaherty, County Surveyor, Kansas City, Mo. March 14.

About 454 ft. of trestling at the Chattahoochee River bridge. J. T. Cooper, Clerk of Fulton Co. Commissioners, Atlanta, Ga. March 11.

City Work.—*Youngstown, O.*—About 4,000 ft. of brick and pipe sewers. G. D. Hersey. March 14.

Bradford, Pa.—About 2,325 sq. yds. of Medina sandstone paving and 6,605 sq. yds. of vitrified brick paving. The City Clerk. March 16.

Glenville, O.—Gravel and slag for road work. C. B. Cook, Village Clerk. March 12.

Buildings.—*Vicksburg, Miss.*—U. S. building, J. H. Windrim, Supervising Architect, Treasury Department, Washington, D. C. March 18.

Geneva, N. Y.—Armory. Josiah Porter, Adjutant-General, S. N. Y., Albany, N. Y. April 1.

Harbor Work.—About 1,800 lin. ft. of pile protection work at Toledo Harbor, O. March 11. About 244 lin. ft. of pier and general repairs at Ashtabula Harbor, O. March 12. Major L. Cooper Overman, U. S. Engineer Office, Cleveland, O.

Galveston, Tex.—About 1,000,000 tons of stone and concrete blocks in place for improving the entrance to the harbor. Major C. J. Allen, U. S. Engineer Office, Galveston, Tex. March 30.

Filling.—*New York, N. Y.*—Earth filling on North Brother Id. Health Department, 301 Mott St. March 10.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Pittsburg Locomotive Works, of Pittsburg, Pa., built 125 engines last year. The Baldwin Locomotive Works, of Philadelphia, Pa., have built 2 engines for the Columbus, Hocking Valley & Toledo. The Rhode Island Locomotive Works, of Providence, R. I., have delivered 6 more ten-wheel engines to the Union Pacific, and 2 ten-wheel engines to the Boston & Maine. The Rogers Locomotive Works, of Paterson, N. J., have an order for 10 engines for the Peoria, Decatur & Evansville. The Lima Machine Works, of Lima O., built 58 Shay engines last year. H. K. Porter & Co., of Pittsburg, Pa., are building a light engine for hauling salt on an island in the Gulf of California. The Delaware, Lackawanna & Western is building a culm-burning mogul engine at the works at Utica, N. Y. The Louisville Southern has added 10 engines to its equipment.

Cars.—The Ohio Falls Car Co., of Jeffersonville, Ind., has an order for 6 cars for the Georgia Central, and has delivered 2 to the Louisville Southern. The Gilbert Car Co., of Troy, N. Y., has an order for 12 cars for the New York & Northern. The Buffalo Car Co., of Buffalo, N. Y., is building 100 freight cars for the Delaware & Hudson. The Terre Haute Car Co., of Terre Haute, Ind., is building 500 stock cars for the Pennsylvania, 100 coal cars for the Cleveland & Marietta, and 300 refrigerator cars. The Erie Car Co., of Erie, Pa., has an order for 450 coal cars for the Huntington & Broap Top. The East Tennessee, Virginia & Georgia has placed orders for 900 freight cars. The Louisville Southern has added to its equipment 6 passenger cars, 3 combination baggage and smoking cars, and 500 freight cars of 60,000 lbs. capacity, fitted with automatic couplers.

Car Heating and Ventilating.—The New York, New Haven & Hartford is said to intend adopting the Consolidated Car Heating Co.'s system, using the Sewall coupler. The Emerson Car Co., of Charleston, S. C., has fitted a car with its new system of ventilation. There are 40 cold-air tubes in the side of the car, 40 hot-air registers in the floor, and 22 exhausters in the sides of the monitor roof. The Roberts steam heating system has been given a test on a Baltimore & Ohio car.

Rails.—The Illinois Steel Co. has a contract for 60-lb rails for the Duluth & Winnipeg; also for the St. Paul & Duluth. The Great Northern Ry. is laying 85-lb. rails on the Montana division. The Chicago & Northwestern will make an experiment with the Bargion compound rail.

Railway Shops.—The Missouri, Kansas & Texas will build shops at Greenville, Tex. The plans have been prepared by Mr. Jarvis, Chief Engineer. The Chesapeake & Ohio will make considerable extensions to the works at Clifton Forge, Va.

Switches and Signals.—The Boston & Albany will put up two towers near the Union station at Springfield, Mass., to control the operation of the yards by the interlocking system.

Track Torpedoes.—The Cannon Torpedo Co., of Allegheny, Pa., has introduced a torpedo adjuster, consisting of a long handle, by means of which a torpedo can be placed on the rails from a car without slowing down the train. The torpedo is held to the rail by spring clips.

Companies.—Chicago Complete Combustion Co., of Chicago, Ill.; incorporators, C. B. Curtis, H. C. Staver and N. E. Brownell. Adamantic Brick & Paving Co., of Charleston, W. Va.; incorporators, Geo. Fleming and others. C. Wright Young Co., of East Orange, N. J.; to manufacture builders' supplies; incorporators, C. W. Young and Wm. J. Turner, New York; capital stock, $100,000. Midland Supply Co., of Chicago, Ill.; to manufacture signal lamps and torches, torpedoes, etc.; incorporators, B. L. Cook, Geo. D. Cook and C. W. Palmer; capital stock, $60,000. Curry Signal Co., Danville, Ky.; capital stock, $100,000. American Rail Joint Lock Co., of Albany, N. Y., proposes to increase its capital stock to $250,000; trustees, R. G. Scherer, Elmer Blair. Day Railway Construction Co., of Chicago, Ill; incorporators, S. V. Day, E. T. Getchell, Willard T. Block; capital stock, $1,000,000. American Hydraulic Sliding Ry. Co.; incorporators, Jules Juvenet, Jules Rigoulet and E. T. Cragin; capital stock, $100,000. The Illinois Steel Co., of Chicago, Ill., will increase its capital stock from $25,000,000 to $50,000,000. Northwest Engineering & Construction Co., of Olympia, Wash.; incorporators, J. H. McGraw, W. R. Forrest and H. K. Owens; capital stock, $100,000. American Iron & Steel Co., of Cle Elum, Wash.; incorporators, H. C. Burke, C. C. Hilton, and W. C. Oakley; capital stock, $1,500,000. Columbia Car Coupler Co., of Chicago, Ill., to manufacture car couplers metal ties, and railway appliances; incorporators, Major McGregor W. D. Fullerton and Marcus Hitch; capital stock, $300,000.

Metal Market Prices.—*Rails.*—New York: $28 to $29; old rails, $22 for iron and $17.25 for steel. Pittsburg: $26.50 to $27; old rails, $25.50 for iron, and $18 to $18.50 for steel. Chicago: $31 to $32.50; old rails, $23.25 to $23.50 for iron and $14.50 to $17.50 for steel.

Foundry Pig Iron.—New York: $14 to $17.50. Pittsburg: $15 to $17. Chicago: $14.50 to $16.

Track Materials.—New York: steel angle bars, 1.75 to 1.80 cts.; spikes, $1.90 to $1.95; track bolts, 2.65 to 2.75 cts. with square, and 3.10 to 3.15 cts. with hexagon nuts. Pittsburg: splice bars, 1.9 to 2 cts. for iron or steel; iron or steel spikes, 2.05 cts.; iron track bolts, 2.8 cts. with square, and 2.9 cts. with hexagon nuts. Chicago: splice bars, 1.80 to 1.85 cts. for iron, 2 to 2.05 for steel; spikes, 2 to 2.1 cts.; track bolts, 2.8 to 2.9 cts. with hexagon nuts.

Pipe.—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 47½ and 40 per cent. on black and galvanized butt-welded; 60 and 47½ on black and galvanized lap-welded. Casing, 50 per cent.

Lead.—New York, 4.3 cts. Chicago, 4.1 cts. St. Louis, 4.1 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2 to 2.1 cts.; tees, 2.5 to 2.75 cts.; sheared iron plates, 2.05 to 2.25 cts.; steel plates, 2.05 to 2.15 cts. for tank, 2.35 to 2.6 cts. for shell, 2.6 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.1 to 2.15 cts.; tees, 2.85 cts.; universal iron mill plates, 2.15 cts.; sheared steel bridge plates, 2.35 to 2.4 cts.; refined bars, 1.9 to 1.95 cts.; steel plates, 2.25 to 2.35 cts. for tank, 2.6 to 2.7 cts. for shell, 2.8 to 2.9 cts. for flange, 4.25 to 4.5 cts. for firebox. Chicago: beams, 3.2 cts.; channels 3.2 cts.; angles, 2.25 to 2.35 cts.; tees, 2.7 to 2.85 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.65 to 2.75 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets 4 to 25 cts.